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METHOD AND APPARATUS FOR DELIVERY OF TELEVISION PROGRAMS AND TARGETED DE-COUPLED ADVERTISING

Related Applications

This application claims the priority of provisional application serial no. 60/215,450, filed June 30, 2000, and 60/226,437 filed August 18, 2000.

FIELD OF THE INVENTION

This invention relates generally to the storage and presentation of broadcast content, and more particularly, the storage and presentation of broadcast content by intelligent preference determination agents.

SUMMARY OF THE INVENTION

In one aspect, the present invention provides a method for displaying a TV program to a viewer, comprising receiving a plurality of TV programs, allowing the viewer to select one of the plurality of received TV programs for viewing, and responding to the viewer selection by controlling the programming displayed to the viewer in accordance with the viewer selection and with previously determined viewing preferences of the viewer.

In further aspects, the method of the invention comprises displaying the viewer selected program and additional programs selected in accordance with the previously determined viewing preferences of the viewer, and

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also displaying one or more advertisements. The method may further compris receiving a plurality of additional programs, as well as selecting one or more of the received additional programs in accordance with the previously determined viewing preferences of the viewer for display to the viewer.

In an additional embodiment of the invention, a method is provided for displaying a TV program to a viewer comprising transmitting a plurality of TV programs for selection therebetween by the viewer, and transmitting a plurality of additional programs for selection therebetween in accordance with previously determined viewing preferences of the viewer, the selected additional programs for display to the viewer with the selected TV program.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a high-level block diagram of a Program selection device employing the principles of the present invention.

Figure 2 is a high-level block diagram of a system employing the principles of the present invention.

Figure 3 shows two examples for Program information.

Figure 4 shows examples for traits and Liking values.

Figures 5a-b are flowcharts illustrating the Data analysis performed on a representative sample.

Figure 6 illustrate the process of computing the error in prediction of user choices

Figure 7 illustrate a step in the process of regression analysis

Figure 8 shows the relationship between two correlated traits.

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Figures 9a-c illustrate the process of determining trait-ness of a trait in a program.

Figure 10 is a block diagram-showing an example for the Liking distribution record format.

Figure 11 lists some sample values for different fields described in Figure 10.

Figure 12 is a block diagram showing an example for the trait-ness record format.

Figure 13 shows an example for broadcasting trait-ness as a part of EPG data

Figure 14 shows an example for user selection record format.

Figure 15 is a block diagram showing the inputs and output for the generation of user selection history

Figure 16 is a flowchart illustrating the process of learning the liking values, performed on a program selection device.

Figure 17(a) is a block diagram showing the inputs and output for the computation of relevancy value for selection history record.

Figure 17(b) is a graph representative of relevancy over age.

Figure 17(c) is a graph representative of repetition rate over relevancy.

Figure 18(a) is a block diagram showing the inputs and output for the process of updating of past selection history

Figure 18(b) is a flowchart illustrating the process of updating of past selection history

Figure 19 is a flowchart illustrating the process of computing liking values performed on a program selection device.

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Figure 20 is a block diagram showing the inputs and output for the computation Liking for programs.

Figure 21a illustrates distribution of income for different programs.

Figure 21b illustrates distribution of gender for different programs.

Figure 22 is a system architecture for providing targeted advertising.

Figure 23a is a graph illustrating the relationship between Belief function and probability for a user belonging to particular demographic trait value.

Figure 23b is a flow chart of a demographic trait record format.

Figure 23c is a flow chart of an advertisement targeting record format.

Figures 24 and 25 are block diagrams illustrating operation of certain functions performed by the television recording system of Figure 1.

Figures 26(a)-b illustrate alternative hardware configurations in systems embodying the principles of the present invention.

Figure 27 is a flowchart illustrating additional aspects of operation of the television recording system of Figure 1.

Figure 28 is a block diagram of one embodiment of a system for providing EPG data and text data to a viewer.

Figure 29 is a block diagram that illustrates one embodiment of a data controller for receiving EPG data and text from data providers, formatting the data for display and inserting the data into a vertical blanking interval of a cable television channel.

Figure 30 illustrates one embodiment of an information field of the EPG data read from the EPG database of Figure 29.

Figure 31 illustrates a data format of data read from the database for insertion into an assigned cable television channel.

Figure 32 is a flow chart illustrating the operation of the EPG transaction formatter of Figure 29.

Figure 33 is a flow chart illustrating one embodiment of the operation of the text transaction formatters of Figure 29.

Figure 34 illustrates one embodiment of a set top box for use in receiving text data and EPG data.

Figure 35 depicts a functional block diagram of another preferred embodiment of a system employing the principles of the present invention.

Figure 36 is a DVCR state diagram for the DVCR shown in Figure 35.

Figures 37-51 depict various aspects of a system according to the invention.

Figures 52-53 illustrate diagrams of operational flow and business models for an AD Manager System according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In Figure 1, a television control system 100 operates in accordance with the principles of the present invention to cause recordation of television programs in response to user inputs 102 and television signals 104. Television control system 100 transmits signals to a television monitor 108 for viewing by the user. Preferably, in digital embodiments,

programs that are recorded by system 100 are presented to the user in the form of additional channels. Thus, the user can rapidly determine, by changing channels, the stored programs that are available for viewing. The user can also change channels between stored programs or between stored programs and currently broadcast programs. If the user changes channels from a recorded program to another program, playback of the recorded program is preferably paused. Alternatively, whether the playback of the recorded program is paused or continued, is a user selectable option. As described further herein, the user may specify programs for recordation by specification of a particular program, or by specification of particular attributes of the program such as comedy/drama, actor(s). When manually specifying programs for recordation, the user may specify that the program is to be recorded once or repeatedly, such as weekly, when broadcast.

Signals 104 include a first component 105 which contains the information necessary to display video and audio components of a television program on television monitor 108. Signals 104 preferably also include a second component 107 termed herein "attribute information." An example of such attribute information 107 is the information available by way of the DVB-SI and ATSC-SI formats and various proprietary formats such as StarSight EPG Data and TVData available from StarSight Telecast, Inc., Fremont, CA, and TVData, Glen Falls, NY, respectively.

Attribute information 107 for any particular program varies depending on the program type, but typically includes a plurality of categories such as start time for the program, duration of the program, the title of the program and other,

attributes (categories) of the program, together with an associated value corresponding to each of the categories.

Recording manager 112 operates to cause recordation and storage of television programs 105 and attribute information 107 in accordance with information generated by preference agent 110 and stored in preference database 116. Recording manager 112 also responds to user requests to record particular programs and to user requests to record programs having specified category-value pairs.

The signals transmitted to the monitor 108 preferably take a conventional analog form. Alternatively the signals transmitted to the monitor 108 maybe digitally encoded. The exact form of the signals transmitted to the monitor is not critical and may take a form as required by a particular monitor. The television signals 104 received by the television control system 100 may take one of a variety of signal formats including analog encoded signals that are encoded in accordance with the well known NTSC or PAL standards. Alternatively, the signals 104 may be digitally encoded in a manner as transmitted by commercially available digital satellite systems (DSS) or in accordance with the MPEG-2 (Motion Picture Expert Group - 2) standard. In any given embodiment of television control system 100 the signal 104 may take a variety of the aforementioned forms. For example, television control system 100 may be coupled to receive inputs from a digital satellite system, the inputs being digitally encoded. The television control system 100 may also be coupled to receive inputs from a Community Antenna Television System (CATV) in which the signals are either encoded in analog or digital form. The television control system 100 may also be coupled to receive analog or digital signals from a conventional home antenna.

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The attribute information 107 may be transmitted to the television control system 100 contemporaneously with the television program 105 in a variety of ways including industry standards, such as DVB-SI (Digital Video Broadcasting-Service Information) as defined by the European Telecommunication Standards Institute (ETS), or the ATSC digital television standard as defined by the Advanced Television System Committee (ATSC). By way of example, in the DVB-SI protocol, programming for the next six hours is transmitted every eight seconds for each channel. As a further example, program information for the next seven days is available from the interactive on-screen TV program guide available from StarSight Telecast, Inc. Programming information further into the future, such as for the next seven days, may also be obtained in other ways. For example, by receiving the information in a time-multiplexed manner over a particular channel. Such information can easily be transmitted when the user is performing an action that does not require a moving video image on the screen, such as when the user has a control menu displayed on the screen.

Alternatively, television control system 100 can download the attribute information 107 separately from the television program 105 by way of a separate communication session via a modem or the Vertical Blanking Intervals (VBI) contained in television signals. Such separate communication sessions include data download mechanisms supported by the MPEG-2, DVB-SI and DSS protocols.

The attribute information 107 can take a form under the DVB-SI protocol as shown below:
event_id,
start_time.
duration,

DESCRIPTOR1,

DESCRIPTOR2,

...

DESCRIPTORn.

The event-id field Is a unique alpha-numeric code assigned to
a program. DESCRIPTORS can be "Short Event Descriptors,"
"Extended Event Descriptors" or "Content Descriptors" which
include the following information:

     Short Event Descriptor:

     {

          event_name-length

          event_name,

          event_description-length

          event_description

     }

     Extended-even

     {

          ITEM1

          ITEM2

          ...

          ...

          ITEMn.

     }

     content descriptor:

     {

          CONTENT1,

          CONTENT2,

          ...

          ...

          CONTENTn.

     }

ITEMs include the following information:

```
{
        item_description_length,
        item_description,
        item_value_length,
        item_value
}
```

An example of item descriptions can be "Director" and item value can be "Martin Scorsese". CONTENT includes the following information:

```
{
        DVB-SI defined theme,
        DVB-SI defined sub-theme, programmer defined theme,
        programmer defined subtheme,
}
```

An example of theme and subtheme are MOVIE and COMEDY, respectively. The programmer defined theme and sub-theme are values that may be provided by the EPG Data provider.

Referring now to Figure 2. preference determination is used to predict a user's preferences in the choice of TV programs. This prediction is based on, (i) analysis of the individual users viewing habits, (ii) analysis of the viewing habits of a representative sample of users and (iii) EPG data for the television programs available during the period of the collected sample.

One method for creating a preference determination is through the use of a Bayesian network that is used to predict user behavior, and hence a preference agent, is a knowledge based approach. In this method a knowledge engineer interviews an expert about the Field of expertise of the expert. The expert and the knowledge engineer determine the distinction of the worlds that are important for decision making in the field of the expert. The knowledge engineer

and the expert next determine the dependencies among the variables and the probability distributions that quantify the strengths of the dependencies.

A second method is Bayesian network is a data based approach. In this second method the knowledge engineer and the expert first determine the variables of the domain. Data is then accumulated for those variables, and an algorithm applied that creates a belief network for those variable data accumulated for those variables, and an algorithm is applied that creates a the belief network to predict user behaviors from this data. The accumulated data comes from real world instances of the domain. This second approach exists for domains containing only discrete variables.

Bayesian methods can be performed by utilizing an algorithm known as the "EM" algorithm, which, as recognized by those skilled in the art, calculates the maximum a posteriori values ("MAP values") for the parameters of the model to predict user behavior. The EM algorithm is described in Dempster. Maximum Likelihood From Incomplete Data Via The EM Algorithm, Journal of the Royal Statistical Society B, Volume 39 (1977), incorporated herein by reference.

After calculating the probability for each variable, each variable within the belief network is then scored for goodness in predicting the preferences of the user by rendering a subscore. As recognized by those skilled in the art, the subscores are generated by using the marginal likelihood of the expected data at the maximum a posteriori values.

One skilled in the art will recognize that any standard model to predict user behavior inference algorithm can be used to perform this step, such as the one described in

Jensen, Lauritzen and Olesen, Bayesian Updating in Recursive Graphical Models by Local Computations, Technical Report R-89-15, Institute of Electronic Systems, Aalborg University, Denmark, incorporated herein by reference.

Television viewing habits of the population are sampled to generate representative samples of viewer behaviors, 117. This task is typically performed by companies such as Nielsen Media Research, who collects user behavioral samples to conduct market research. The results of the sampling is stored in a viewer behavior database. The format of the viewer behavior database is proprietary to the company conducting the sampling. Viewer behavior database contains demographic information about the people in households participating in the sampling. This information includes but is not limited to race, age, annual income and gender. Viewer behavior database also contains information about all the television programs each viewer watched during the period of sampling.

Program Information and the schedule of television programs is available in the EPG database, 104. Program Information for a television program contains information about various attributes of the program which includes but not limited to the title, program type and program category of the television program, arid also the actors acting in the television program.

Figure 3 lists two examples of program information, example 1, 124, describes the program information for a audio visual television program, and example 2, 125 describes program information for a graphical text based television program.

Viewer behavioral database is analyzed 118 to identify traits of TV programs and determine how such identified

traits influence viewing habits in the representative sample of users. These traits and their influence amongst the viewing population are then used in aiding the process of predicting an individual user's choice in TV programs. Figure 4, 126, lists some examples of such traits. Some of these traits are derived from program information, 104. Some of these traits are derived by looking for users liking for association of multiple traits or association of traits with other viewing parameters which includes but is not limited to time, day of the week, holiday, working day and weather season. Some of these traits are derived by data analysis of Viewer behavioral database. Any given program would exhibit varying degrees of the above identified traits. This is expressed as the trait-ness of the trait in the program, e.g. trait-ness of comedy in Seinfeld may be 1.2 and trait-ness of comedy in Mad About You may be .79. The trait-ness of a trait in a program is computed as a part of the data analysis, 118.

The present invention also provides for a methodology for determining viewer preferences. In one embodiment, an individual viewer picks one show to watch out of the collection of available program by evaluating a stochastic liking function for each program and choosing the program with the highest score. The liking function is modeled as an aggregate of liking for a specific trait and the degree to which that trait is exhibited by that program. The liking function can be computed as:

$$l(p) = \Sigma \; \lambda(tn) \; * \; tn$$

Where

$l(p)$ represents the liking for program p

$\lambda(tn)$ represents the liking for a specific trait tn

tn represents the degree to which the Trait tn is exhibited by p.

When a viewer watches television, it is assumed that the viewer chooses a program for which the value of l(p) is the highest. For any given viewer, the better the values of λ(tn) represent its actual liking, the more the accuracy in determining its preference for TV programs. Thus for any given user if all the relevant traits are known along with the exact liking of each of those traits, the above Liking Function would always accurately predict the liking of any given program.

However, identification of all the relevant traits and the determination of the exact liking of each viewer is a non trivial task and arrived at iteratively by a process of regression analysis.

While a majority of the traits relevant to a specific user may be derived directly from the EPG information itself, some of the traits are discovered by analyzing the user's viewing habits over time. Traits that are suitable for discovery by a process of regression analysis are generally hidden or associated traits.

Hidden traits are those which influence a user's viewing habits but which can not be derived from the EPG information. For example, sitcoms featuring a specific ethnic background would resonate more with viewers of that ethnic background. Another example of the effect of a hidden trait could be the strong liking of the sitcom "Frasier" amongst the set of users who have a strong liking for the sitcom "Cheers." Assuming that the names of actors performing in a sitcom are not be available in the EPG data, this affinity towards both the sitcoms by the same set of people may be explained by the presence of some trait commonly exhibited by both the

sitcoms, namely the presence of one of the central characters in both the sitcoms. Such hidden preference criteria would have to be captured by adding the hidden traits in the computation of the Liking Function.

Associated traits - Traits which have a different influence on a user's viewing habits when combined with other traits. For example a user would have a certain liking for any given Seinfeld episode, and a certain liking for any premiere sitcom being aired for the first time. However, its liking for a premiere episode of Seinfeld may be sufficiently large enough to require an additional trait, "new Seinfeld", to fully explain its liking for a premiere episode of Seinfeld.

The liking of each trait for a given user has to be similarly refined from initial approximations by regression analysis. Examples of traits and the associated liking for a sample user include but are not limited to those listed in Figure 4. The trait "NBC <=> NEWS" is an example of an associated trait where the traits being associated are "Channel NBC" & "Program Type News." Users liking for NEWS programs may be 1 & the preference for the "NBC Channel" may be 2 whereas its preference for NEWS on NBC may be 13, i.e., this user does not always watch news programs or programs in general on the NBC channel, however he has a strong preference for NEWS programs on the NBC channel. If only its liking for the "Channel NBC" & "Program Type News" are considered, its preference for "News on NBC" would be unexplainable.

This procedure to identify traits is first carried out using the viewing habits of the representative sample along with the determination of the distribution of likings of each trait within the representative sample.

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Some of the outputs of the analysis 102, of the viewing habits of a representative sample are a set of preference determination parameters viz. (i) the traits which are exhibited by recurring program and the degree to which such a trait is exhibited, and (ii) a distribution list of the likings amongst the viewing population of each of the above trait.

One methodology to derive these parameters is outlined in Figures 5(a) and 5(b). Different phases of the flow chart are explained further in the following sections. An initial set of liking values are computed for each user, 129. This initial liking value may be arrived at in various ways. One of the ways could be to base it on the amount of time for which a given trait was watched as opposed to the amount of time it was available during the user's viewing period.

Using these initial liking values for the traits the Liking Function l(p) is computed for all the programs that were available during the times the user watched a given program. These programs are then arranged in descending order, 140, of liking value for a time period during which the viewer watched a program, 141. The actual program the user watched at a given time is highlighted, 143. If all the highlighted programs in Figure 6 had the highest score, the Liking Function correctly identified the user's preference. If the program watched by the user ranks below some other competing program available at that time the liking values used do not correctly reflect the user preference. By way of example, but not by way of limitation, if there are N programs ranked above the program actually watched, the error in the Liking Function for this program may be called N, 142. Such values of N are determined for each program watched by the user by comparing it with the Liking Function of the

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other competing programs. In the example illustrated in Figure 6 values of N are computed for the times when the user watched TV between the hours of 10:00-10:30, 10:30-11:00, 11:00-11:30. Using regression analysis, the liking values of each of the traits are adjusted incrementally to reduce the average value of N. The set of liking values which yield the lowest value of the average of N are considered the best set of liking values for that user.

One methodology of the regression process is illustrated in Figure 7. At the beginning of the process liking values for traits a, b, c, are $\lambda a1$, $\lambda b1$, $\lambda c1$,…(144,145). $\lambda a1$ represents the liking of trait "a," $\lambda b1$ represents the liking of trait "b" and so on. The Liking Function of all the relevant programs are computed using this initial set of liking values. The liking value $\lambda a1$ of the first trait "a" is changed incrementally to determine the average value of N. The value $\lambda a2$, 147, which yields the lowest average value of N, is taken as the new liking value for the trait "a." This new value liking value $\lambda a2$, 148, now replaces the old value and is now used to determine the remaining λ values. The above set of liking values computed would predict the users preferences with a high degree of accuracy if set of the traits considered in the Liking Function includes all the traits that are relevant to a user. The average value of N not converging (to 0 or some other acceptable value) would indicate that not all traits that are relevant to the user have been considered in the computation of the Liking Function. Introduction of additional traits, either associated or hidden, is used to improve the determination of the user's preference.

A determination of associated traits is achieved by a variety of different methods. One method is through the

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application of heuristic rules of thumb where the associative value of a number of traits is not reflected in the program information obtained from an EPG but is relevant to human viewing habits. For example, a user who has a liking for Seinfeld would most probably have a much higher preference for a premiere or new episode of Seinfeld. Such heuristic rules of thumb regarding the associative value of a number of traits may be passed to each set top box via the Head End. Another method of determining associated traits is with an algorithmic search which looks for common traits in programs and introduces new associated traits to try to improve the Liking Function for a user.

Determination of hidden traits in different programs can be achieved in a number of ways. One of these methods is illustrated in Figure 8. The possibility of the presence of a hidden traits exists whenever there exists a strong co-relation between any two traits present in different programs. The y-axis represents an increasing liking value for higher values of y. Every point on the x-axis in Figure 8 represents a user arranged such that the liking value of the trait "tn" increases with higher values of x. If for the same values on the x-axis the liking values of a strongly co-related trait "tm" are also plotted, it will exhibit a relation to the liking graph of the trait "tn". The co-relation between any two traits may be explained by he presence of a common hidden trait. Thus traits "tm" and "tn" may be expressed mathematically as

tm = tx + tm'

tn = Ctx + tn'

where C is some constant indicating the amount of co-relation between traits "tm" & "tn".

Hidden traits can also identified by applying rules of thumb or some other appropriate manner.

While ail programs of a specific genre exhibit some common traits, the degree to which these traits are exhibited vary from program to program. This degree of traitness for recurring programs can be quantified such that it best explains the viewing choice of watching or not watching that program in the representative sample. For example consider a user who has a certain liking λ for comedy. The users' decision to watch a comedy program would be influenced by whether the amount of comediness exhibited by that program crosses some threshold of comediness that is determined by its liking for comedy.

One method to determine the traitness of a trait T in a given program N is illustrated in Figures 9(a)-(c). The highlighted program represents the programs actually watched 156 by a user. All available programs are arranged in decreasing order of rank 154 as computed by the Liking Function. In the case of User 1 155 the Program N 156 which was watched by him appears third in rank whereas the Liking Function should have actually ranked Program N at the top. In this case the margin of error 157 in the traitness of trait T is 3. In the case of User 4 the program N watched by the user was ranked the highest. The margin of error in the traitness of trait T is 0. In the case of user 2 where he did not watch Program N, it was ranked the highest. The margin of error in this case can be considered to be a constant K. A suggested value of K may be the number of programs available to the user at that time. Similarly for user 3, the margin of error may be considered K-1. Such margins of error are computed for all users who watched the Program N and the average margin of error is computed.

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Using regression analysis, the traitness value of the trait T is adjusted incrementally to reduce the average value of the margin of error. The value of traitness which yields the lowest value of the average of the margin of errors is considered the best value of the traitness of the trait T exhibited by the program N.

Traitness values may also be assigned by rules of thumb or some other appropriate manner.

One of the outputs of analyzing the viewing habits of a representative sample is a distribution list of the likings amongst the viewing population of each trait. This information is presented schematically in the Figure 10 and is made available to every individual user Set Top Box along with the broadcast TV programs and program information. "Number of traits", 164, represents the total number of traits that have been identified after analyzing the viewing habits of the representative sample. The distribution of liking of each trait is provided in a "Trait Record", 165. Information included in a trait record include the name of the trait, 167, the type of the trait, 168, (whether hidden, associate, etc), the liking distribution of the trait 170, and the distribution parameters, 172, of the trait. Examples of various possible values in a trait record are provided in Figure 11.

Figure 12 illustrates one schematic representation of traits present in recurring programs. This information is passed along with the above liking distribution of traits. The "Number of programs" 173 represents the number of programs for which trait information is sent. Relevant traits and the degree to which they are exhibited are included in the "Program Record" 174. The "Program Identification" 177 information is used to identify the TV

program to which this record pertains. An example of a
Program record for a Seinfeld Episode is given in Figures 13.
As given in the example certain traits such as "Program Name
- Seinfeld", "Channel - NBC", "Program Type - Sitcom" can be
derived directly from the EPG and are called static traits.
Additional traits such as "comedy" which store the degree of
comediness associated with a Seinfeld Program may also be
passed as a part of the EPG data.

Referring again to Figure 2, the program content and the
program information (in the form of an EPG) are transmitted
from a Broadcast Head End along with preference determination
parameters, 119. Examples of preference determination
parameters include but are not limited to (i) the traits
which are exhibited by each program and the degree to which
such a trait is exhibited and (ii) a distribution list of the
liking values amongst the viewing population of each trait.

This information is received in each household by a
program selection device 100, that include a preference
Determination Module, a personal preference database, 116, a
storage device and a display device 108. The personal
preference database 116, is used to store the results of the
analysis of the individual user's viewing habits. The
storage device stores programs as per the user's specific
requests or programs recommended by the preference
determination module.

Program Selection Device 100 monitors each user's
viewing actions and selection of TV programs being watched.
This is stored in a storage device or in memory in the form
of selection history data 189 (see Figure 15). The schematic
representation of selection history data is given in Figure
14. The "Number of selection records", 180 represents the
number of user selection choices stored in the selection

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history data. Each selection record 181, contains the
information on the actual programs watched 185 along with
information on the competing programs available at that time
186. Storing program information is required as the EPG may
not be able to provide information on past programs.
Information on these program may be obtained directly from
the EPG data when the information is obtained while the
program is still current. The time 183 and duration 182 for
which a program was watched also form a part of the selection
record. As illustrated in Figure 15, a uses selection
history 189 is derived from each choice 187 made by the user
along with program information from the EPG 104.

One process of learning the user preferences of a
specific individual is illustrated in Figure 16. The liking
distribution in the representative sample for traits
identified by data analysis, 118, are used by the Liking
Function to minimize the effect of error introduced because
of lack of sufficient sampling in the computation of the
liking of the identified traits by an individual. An
individual user's response to setup question 190 may also be
factored in determining initial values of liking for that
individual 192.

A user selection history 189 is maintained for a fixed
number of hours. The number of hours for which the user
selection history is maintained can be preferably changed to
have an increased rate of learning during initial days of a
new user using the device. Average Error is computed N 194,
in a similar manner as for users; in the representative
sample, as previously described in Figure 6. If the average
error is greater than a tolerable limit 195, new liking
values are computed 198. Entries in the user selection
history are moved to the Past selection history. If the

Average error remains under a tolerable limit the liking values are computed only after a predefined number of hours 196.

Another embodiment of the selection record stores a program ID instead of the entire program information. In this embodiment, the actual program information is broadcast at predetermined times from the Head End where each program is identified by the same program ID stored in the selection record. In this embodiment, the computing 198 of liking values for traits are performed only at this predetermined time.

Referring now to Figure 17(a), after each computation of liking values, entries in the user selection history is moved to the Past selection history. Selection history is partitioned as user selection history 189 and Past selection history 216 to optimally store the section history records. Selection history contains information about all selections made by the user between two computations of Liking values. Past selection history maintains the most relevant information about the most relevant selections made by the user in past. The number of records in the Past selection history can be advantageously configured to suite the memory available for storage of such records. Relevancy in this context is the importance of the record in computing the liking values and is dependant on many parameter including but not limited to the age of the record 200, the repetition rate 203 of traits contained in programs 204 in the selection record. The relationship between relevancy and age 205 of the record is shown in Figure 17(b). The most relevant records are the most recent records. The relationship between relevancy and the repetition rate of traits contained in programs in the section record is shown in Figure 17(c).

As the repetition rate decreases, the relevancy increase 206, till certain limit after which the relevancy decreases 207. A good example to illustrate the reasoning behind this relationship would be relevancy of keeping records on user selection when Seinfeld a weekly program is available and the relevancy of keeping records on user selection when Olympics a 4 yearly program is available. While it is important to keep records about Seinfeld to compute likings of various traits contained in Seinfeld, it is pointless to keep records about viewer's liking for the last Olympics. Consider a user who does not have a liking for movies except on Fridays. To accurately determine the user likings of trait of "Friday night-ness" of a movie, the selection records pertaining to its viewing actions on a Friday have to be maintained for at least a number of weeks. However if the repetitive nature is too far apart in time, the relevancy decreases sharply. The "Relevancy versus Repetitive Rate of a Trait" graph in Figure 17(b) measures increasing values of relevancy for higher values on the y-axis. The x-axis measure decreasing rates of repetitiveness of a trait in a program. As shown in Figure 17(a), beyond a certain threshold of repetitive rate, the relevance decreases sharply.

The process of updating of past history is shown in Figures 18(a) and 18(b). The processing is done for every record in the user selection history. If there is enough memory to store the new record in the past selection history 218, the record is removed from the user selection history and added to the past selection history 222. If there is not enough space in the past selection history 218, the records in the past selection history are sorted based on relevancy 220, and :he least relevant record is deleted 221 to make space to add the new entry 222.

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In another embodiment of the present invention, the number of available programs 186 stored in the past selection history can be limited to an optimal number to make best use of the memory available (see Figure 18). In this embodiment only the programs with higher values of liking, representing the traits which have significant liking values, are stored in past selection history record.

Computing of Liking values for different traits performed by the Program selection device 100 is shown in Figure 19. This process is performed 198 during the learning process as explained by Figure 16. Regression analysis is performed to minimize error in prediction of viewer behavior stored in user selection history and past selection history by using current liking values as the starting point. The regression analysis process 223 is the same as the one performed in representative sample 131. If there are any selection record for which the error is more than a predefined threshold 224, the selection record is examined for the presence of possible associated traits 225. The rules which defines the presence of possible associated traits may be rules of thumb. Possible association of traits can also be discovered by looking up the list of associated traits which were discovered from the representative sample. Liking for possible associated traits are computed by regression analysis 226. If the computed liking is a significant value 231, the liking for trait is entered 230 into the preference database 116. Other parameters like the repetition rate for the trait also is entered into the database 230. The repetition rate is computed by looking at the repetition rate of the trait in user history and past history. If there are no previous selection record with this trait, then the repetition rate is assumed as a predefined

value. As new selection records are created, the repetition
rate is updated. At the end of the process (illustrated in
Figure 19) of computing the liking values, a weighted average
of the current liking values and the old liking values is
computed. This forms the new set of liking values. Learning
rate can be increased or decreased by changing the weight of
the current liking values.

A flow chart of computing scores for programs for future
prediction is illustrated in Figure 20. As described earlier
Liking 236 for a program 232 is computed by evaluating the
function $l(p) = \Sigma \lambda (tn) * tn$. $\lambda(tn)$ is computed as a
weighted average of liking for the trait tn for the user 234
and the liking for the trait tn for the general population
235.

In another embodiment of the present invention which is
suited to function on program selection devices operating on
households with multiple users, the viewer is asked to input
the number of viewers in a household during the initial setup
process. Each viewer can answer a set of setup questions
which would capture their liking for representative traits.
An initial set of possible liking values are created for each
viewer. Learning process updates each viewer's preference
database separately after identifying each viewer session
correctly. Viewer identification is done either by explicit
input from the viewer identifying the viewer or automatically
by identifying the viewer by monitoring the television
viewing behavior of the viewer. To identify a viewer
automatically, the error value between predicted and actual
is computed for all viewers. The viewer with liking value
which yields the least error value is chosen as the possible
viewer. The certainty of this decision is expressed as a
probability which is computed as a function of the

differences between error values for different viewers in
this household.

The objective of the present invention is to determine
demographic characteristics of a user by analyzing the users
viewing habits in juxtaposition with viewing habits of a
representative sample of users whose demographic
characteristics are known. These demographic characteristics
of a user collectively constitute a demographic profile.
Upon successful creation of an accurate demographic profile
for a user, the present invention can receive a collection of
possible ads and show individual users only those which are
targeted to a matching profile.

Some example of demographic characteristics include, but
are not limited to, a users gender, race, age and income.
The output of the analysis of viewing habits of the
representative sample provides a basis for determining
demographic characteristics of the individual user.

The TV programs chosen in the analysis of viewing
habits, of the representative sample, plays an important role
in determination of a demographic characteristic. Different
TV programs might be required to determine demographic
characteristics. Typically TV programs where a majority of
its viewing audience share a common demographic
characteristic, in a proportion which is different from what
is observed in the general population, are best suited in the
discovery demographic characteristics. For example to
determine the "income" demographic characteristic consider
graph (i) in Figure 21a. The x-axis represents the annual
salary in increasing order of x. For any point in the x-
axis, the y-axis represents the probability of finding an
annual salary of x in the representative sample (which is the
same in the general population). Now consider graph (ii),

where the dotted curve plots the same income distribution represented in the graph (i), the first solid curve (the leftmost curve) shows the income probability distribution of the viewing audience for program P1 in the representative sample and the second solid curve represents the income probability distribution of the viewing audience for program P2 in the representative sample. Analysis of the viewing habits of an individual user for the above programs P1 & P2 could be used to determine his most probable annual income. Using Bayesian inference this probability may be expressed by the following mathematical formula

$$P(Ixy|Wp1)=P(Wp1|Ixy)P(Ixy)/P(Wp1)$$

where

- Ixy represents an annual income range of x-y
- Wp1 represents watching program p1
- P(Ixy|Wp1) represents probability of income of Ixy given the fact that program p1 was watched
- P(Wp1|Ixy) represents probability of watching program p1 given the fact that the annual income is Ixy
- P(Ixy) represents probability of income of Ixy in the representative sample
- P(Wp1) represents probability of watching program p1 in the representative sample

Thus for a user who watches program p1, the probability of his income being within a certain range can be determined.

Programs whose viewing audience display a demographic characteristic in the same proportion as is observed in the representative sample (which is the same in the general population) do not contribute significantly in determining demographic characteristics. Consider the graphs in Figure 21b. Graph (i) shows a bar graph which represents the

probability of a person in the representative sample being male or female. The graph (ii) shows the probability of person being male or female within the viewing audience of program P3 which is very similar to what is observed in the general population. If Bayesian inference is used to determine the gender of a person who has watched program P3, the probability of the person being a male or a female would be the very close to the probability of person being a male or a female in the general population (which is already a known value). Nothing significant is gained by analyzing the viewing habits of the individual for the program P3. On the basis of the graph (iii) on the other hand, analyzing viewing habits for program P4 would yield additional certainty in determining the gender of a person than what is already known about the gender distribution in the general population.

The determination of which programs yield high probability values in determining a demographic characteristic of a user may be done by applying rules of thumb through an algorithm which chooses the program on the basis of how much a demographic trait in it viewing audience differs from what is observed in the general population by some other means.

Depending on the program content and the demographic characteristics of its viewing audience, the same television program maybe used to determine one or more traits. It is also possible that a completely different set of programs are required to study different demographic characteristics.

While it is possible from Bayesian inference to ascribe a certain preference for a specific show based on a users demographic characteristics, it may not be the only factor which explains the users choice of a particular show. For example, consider the graph (ii) in Figure 21a. It might be

possible for a user, U1, having income less than x1 having a strong preference for program P2 for unknown reasons. So just using Bayesian inference to arrive at U1's most probable annual income based on his viewing habits of only a single program P2 would not yield the most meaningful result. To strengthen the belief of a Bayesian inference, the users viewing habits have to be analyzed for a set of programs where the viewing audience of each program from that set displays a similar demographic characteristics. The programs of the set are so chosen that degree of co-relation of traits exhibited by the programs in the set are minimal. Each program that the user views from this set of programs adds towards strengthening the belief of the Bayesian probability of the user possessing that demographic characteristic.

To explain the need for minimal co-relation consider the previous example. If another program P3 which is very similar to P2 in content and has the same demographic traits in its viewing audience as P2 is available to user U1, he would have a similar liking for P2 as P3. In this scenario strengthening the belief of the Bayesian probability by the user U1 watching program P3 is not a positive contribution. However if program P3 were very different in contents and the traits that it exhibits, the probability of U1 choosing P3 is greatly diminished and keeps the belief in the Bayesian probability from erroneously rising. In this situation the probability of a user who actually possessed the demographic characteristic of watching both programs P2 &: P3 would be quite high and the strengthening of the belief would be a positive contribution.

Thus a Belief Function for the Bayesian probability for a demographic characteristic dc1 may be computed in many ways which includes but is not limited to

BF(dc1) = MAX(bp(w1), bp(w2) .., bp(wm))*cr1 +

MAX(bp(wk), bp(wk+1) .., bp(wk+m))*cr2 + ... +

MAX (bp(wn), bp(wn+1) .., bp(wn+m))*cm

where

- bp(wn) is the Bayesian probability of a user having that demographic characteristic given the fact that he watched program wn

- (w1, w2, ... wm), (wk, wk+1, ..., wk+m), (wn, wn+1, ..., wn+m) are sets of programs where any member of a set has a high degree of co-relation with another member of the same set, but a very low degree of co-relation with a member of another set.

- MAX(bp(wn), bp(wn+1) .., bp(wn+m)) represents the maximum

Bayesian probability value of all possible values within that set

- cr1 represents a co-relation co-efficient of the set (w1, w2, ... wm), c2 represents co-relation co-efficient of the set (wk, wk+1, ..., wk+m) and so on. Elements of the same set have the co-relation co-efficient.

The Belief Function for any demographic characteristic is illustrated by the S curve in Figure 23a. The x-axis represents increasing values of the Belief Function for a demographic characteristic for increasing values of x. The y-axis represents increasing values of the probability of a user displaying that demographic characteristic for increasing values of y. As shown in Figure, the probability does not increasing any further for higher value of the Belief Function.

Some of the output of the analysis of viewing habits of the representative sample are schematically illustrated in Figure 23b:

Display of advertisements by a program selection devices done when a users computed demographic profile matches the target profile of the advertisements. Some of the elements contained in an advertisement is the advertisement contents (maybe video clip, audio clip, Graphical or textual information) and the meta data which includes information on the demographic profile for which this advertisement is targeted.

The meta Data contained in an advertisement is represented schematically in the Figure 23c.

Here "Number of Target Records" refers to the number of "Target Records" included in this "Target Ad Meta Data". Each "Target Record" refers to a demographic characteristic that this advertisement is targeted to. The 'Target relationship rule" is used to determine the relationship rule. For example if the advertisement is targeted towards user who satisfies any one of the following criteria

- income level is between Ix & Iy
- ethnic background is eb1

The "Target relationship rule" would be used to specify the above relationship.

The "Demographic Trait Data" determined by analysis of viewing habits of a representative sample with known demographic characteristics and the "Target Ad Meta Data" are broadcast to a Program Selection Device from a Broadcast Head-end along with program content and EPG data. This is illustrated in Figure 22. This is received by each user at each Program Selection Device to determine the user demographic profile. Broadcast of the "Demographic Trait

Data" and "Target Ad Meta Data" along with the advertisement content may be done on a periodic basis, or may be made always available on the broadcast networks or through some other communication mechanisms on an as-needed basis.

At the Program Selection Device the "Demographic Trait Data" and "Target Ad Meta Data" are collected and stored in a storage device such as, but not limited to, a hard disk, flash ROM or main memory. Collection of this data may be done at fixed time periods or whenever suitable depending on the embodiment chosen. For each trait record in the "Demographic Trait Data", the Program Selection Device goes through past Selection History. Each program on the "Trait Value Record" that is available in the past Selection History is used in the computation of the Belief Function. The Belief Function Distribution graph in the "Trait Value Record" is then used to determine the probability of the user having that demographic characteristic. If an earlier probability for this demographic characteristic is available a weighted average of the old probability and the newly determined probability is taken and stored.

Each targeted advertisement where the "Probability satisfaction criteria" of the "Target Record" is met by user's demographic profile is chosen for display at the appropriate time.

Referring again to Figure 1, television control system 100 is preferably implemented by way of a general purpose digital computer and associated hardware that executes stored programs to implement the functions shown within block 100. The exact hardware and software platforms on which the television control system 100 is implemented is not important and may take a variety of forms. For example, television control system 100 may be implemented in a set-top box such

as may typically used by individuals in the home to receive CATV signals. Another implementation of television control system 100 is in the form of a personal computer configured with the requisite hardware and software to receive and display television signals. An example of a set-top box that maybe programmed in accordance with the principles described herein is described in the following documents by IBM Microelectronics: "Set-Top Box Solutions", Product # G522-0300-00 (Nov. 19, 1997); "Set-Top Box Reference Design Kit", GK10-3098-00 (April 15, 1998); "Set-Top Box Peripheral Chip", GK10-3098-00, (April 15, 1998); "Set-Top Box Solutions: Helping Customers Meet the Challenges of Convergence", G522-0300-00 (Nov. 19, 1997); and "The challenges of convergence for Set-Top Box manufacturers", G599-0302-00 (Nov. 19, 1997). An example of an Application Programming Interface (API) available for set-top boxes which can serve as a platform for the embodiments described herein is described in "API Requirements for the Advanced Set-Top Box" published by OpenCable (Oct. 21, 1997). An example of an operating system incorporating functionality to support the embodiments described herein is available from OpenTV, Inc. and is described in the following Technical White Paper publications by OpenTV, Inc.: "OpenTVTM Operating Environment" and "Application Development for OpenTVTM." An advantage of such an operating system is the support provided in the form of function calls to obtain attribute information 107 from the signals 104. Alternatively, a general purpose operating system such as the Windows NT operating system from Microsoft Corporation may be used in conjunction with additional software that provides the functions required to extract the necessary information from attribute information

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107 and to perform other manipulation of the received signals 104 and the stored information 105.

Storage devices 106 may include a variety of different types of storage devices. For example preference database 116 may be stored in a non-volatile, random-access semiconductor memory. Television programs 105 and attribute information 107 may be stored on storage devices having greater capacity such as a conventional magnetic, hard disk drive. In general, storage devices 106 are understood to encompass a variety of storage devices. The exact form of the storage devices 106 is not critical so long as the storage devices have the capacity and speed to store the necessary information. Storage devices 106 may also comprise a conventional video cassette recorder (VCR) which operates under control of system 100 to store television programs 105 and attribute information 107 on conventional magnetic tape.

For the purposes of the present description, the television control system 100 is presumed to be integrated into, or coupled to, a system including a tuner and other functions necessary to receive television signals and to extract the attribute information 107 from the television signal and to perform other functions typically associated with the receipt and viewing of television signals. In certain embodiments, television control system 100 may operate in conjunction with a database agent that facilitates interaction with preference database 116 by causing storage and retrieval of information to or from the database in an optimal manner. The preference database 116 may be implemented by a commercially available database product such as the Oracle Light database product available from Oracle Corporation which also incorporates the functionality to implement the data base agent described above.

Recording manager 112 causes recording of programs 105 by periodically initiating a sequence of steps shown in Figure 24. At 201, recording manager 112 sends a request to preference agent 110 for ratings of all programs at a particular time (X), or alternatively, for ratings of all programs within a particular time period (X). By way of example, the steps shown in Figure 2 may be performed every six hours. In certain embodiments, the frequency with which the steps in Figure 24 are performed may be changeable by the user. Preference agent 110 responds at step 202 by providing ratings, from preference database 116, for each program received from recording manager 112. Recording manager 112 then causes recordation of the programs at time X, or within time period X in accordance with the ratings received from preference agent 110. Specifically, programs having the highest rating are given highest preference for recordation and programs having the lowest rating are given lowest preference to recordation. The recordation is subject to storage capacity constraints. For example, if the highest rated program is one-hour long, and only thirty minutes of recording space is available on storage devices 106, then the one-hour program is skipped and the highest rated thirty-minute program is recorded.

Highest priority for recording of programs is given to programs specifically requested by the user. For example, if the user identifies a particular program for recording, such as by specifying the date, time and channel, or by specifying an identification code for the program, recordation of that program is given priority over programs rated by the preference agent. Next highest priority is given to programs matching particular category-value pairs specified by the user. For example, if the user does not identify a

particular program, but specifies that one-hour long documentaries pertaining to travel should be recorded, then recordation of programs matching such category-value pairs is given priority over programs rated by the preference agent 110. In alternative embodiments, relative priority between user-specified programs, user-specified category-value pairs and programs rated by the preference agent 110 is changeable by the user.

Recording manager 112 manages storage capacity on storage devices 106 by causing deletion of television programs 105 in accordance with ratings of such programs generated by preference agent 110. This is performed in a manner similar to that explained above for determining which programs to record. Figure 25, which shows the steps taken by recording manager 112 to determine which programs to delete, is similar to Figure 24. At step 301, recording manager 301 requests ratings from preference agent 110 of all programs stored on storage devices 106. At step 302, preference agent 110 responds by providing the requested deletion ratings. At step 303, recording manager 112 responds by causing deletion, when needed, of programs in accordance with the deletion ratings received from the preference agent 110. Specifically, when additional space on storage devices 106 is required to record one or more additional programs, recording manager 112 causes deletion, or overwriting of programs having the lowest rating first. Thus, stored television programs which are determined by preference agent 110 to be least preferable, in relation to other stored television programs, are deleted or replaced first, and those determined to be most preferable are deleted or replaced last. Deletion of programs occurs only when required. Advantageously, this results in storage device 106

typically being filled to maximum capacity, thus providing the user with as wide a variety of programs as possible. The user can specify programs that are to remain on the storage device 106. Such programs are not deleted by the recording system 100 in the steps shown in Figure 25. In addition, the user can specify programs that are to be deleted, and therefore override the steps shown in Figure 25.

In certain embodiments, the preference database is used by system 100 to alter the manner in which information about currently broadcast programs is presented to the user. For example, in such embodiments, the preference database is used to rearrange the order in which currently broadcast programs are presented to cause programs having attribute information 107 rated highest by preference database 116 to be presented first. Alternatively, the preference database 116 can be used to organize information regarding the currently broadcast programs according to the liking of various traits stored in the preference database.

Figures 26a and 26b illustrate alternative hardware configurations for systems employing the principles of the present invention. Figure 26a illustrates a hardware configuration that supports storage and retrieval of digitally encoded audio and video. Interface 902 is a standard digital cable or digital satellite input interface. Interface 906, which is the hardware interface to storage devices 106 preferably takes the form of an IDE or SCSI interface, or the proposed IEEE-1394 interface. Interface 906 is an NTSC or PAL encoded video interface. If the television signal 104 takes the form of an analog signal, as in the case of most current television broadcast signals, and CATV signals, then the signal 104 must be digitized and generally compressed (for example, by the MPEG-II standard)

before storage on a digital storage medium such as shown in Figure 26a.

Figure 26b illustrates an embodiment using an analog storage device 106 such as a conventional VCR. If the television signal 104 is analog then the interface 910 takes the form of a conventional NTSC or PAL interface. If the television signal 104 is digital then the interface 910 takes a form as interface 902 shown in Figure 26a and a digital-to-analog converter is required to convert the received signal to analog form before storage on storage device 106.

Figure 27 illustrates operation of an automatic pause-record feature of preferred embodiments. If a user is watching a currently broadcast program and wishes to stop or temporarily pause viewing of the program, the recording system 100 advantageously allows the program to be recorded so the user can resume viewing the program at a subsequent time. As shown in Figure 27, at 1002, the user is viewing a currently broadcast program. Generation of a pause input at 1004 by the user, such as by pressing of an appropriate button on a remote control coupled to the recording system 100, causes the system 100 to cause at 1006, recordation of the program being viewed by the user. The user is then free to watch another program or stop watching the television 108 altogether. At a subsequent point in time, if a resume viewing input is received, such as by pressing of an appropriate button on the aforementioned remote control, then at 1010, the recording system 100 causes the program recorded at step 1006 to be retrieved and shown on the television 108 from the point the recordation was initiated at step 1006. If the program is still being broadcast when step 1010 is initiated, then recordation of the program continues by the

system 100. The user thus can easily interrupt viewing of a currently broadcast program and resume subsequent viewing.

Preferably the recording system 100 supports a variety of functions such as fast-forward, rewind and visual scan of stored programs, and other functions supported by the storage medium 106. For example, if the storage medium 106 takes the form of a VCR then the program viewing and manipulation functions will be limited to the standard VCR functions of fast-forward, rewind, forward or reverse visual scan. If the storage device 106 takes the form of a digital storage medium then more advanced program search and retrieval functions can be supported.

It will be appreciated that the functions performed by the preference agent 110 and the recording manager 112 are illustrative of a particular embodiment. However, the division of tasks between the two modules 110 and 112 may be changed. In addition, the data formats 115, 116, 105 and 107 may also take a variety of forms.

Figure 28 illustrates an EPG and text information service in accordance with one embodiment of the present invention. As shown, a local cable television company's billing vendor 10 communicates via a billing link to an RS-232 port of a system manager 12 located at a cable head end. Billing vendor 10 includes a subscriber database and generates a monthly bill for the subscribers in the system based on the level of service and any pay-per-view purchases. System manager 12 can be a personal computer or other processing device which receives viewer authorization transactions from billing vendor 10 and generates transactions for delivery to the distribution apparatus or the subscribers. Such transactions include text channel definition transactions which instruct the subscriber's set

top box which group of channels it is entitled to receive, which frequency to tune for a particular text data channel, whether to mute the audio for that text channel, the pagination delay between pages, and the like.

System manager 12 also communicates via a head end link to an RS-232 port of a head end controller (HEC) 14 which controls the transmission of television programming to the subscribers. As will be described in more detail with respect to Figure 29, HEC 14 communicates via a control link to an RS-232 port of an information services processor (or data controller) 16 which manages the flow of EPG and text data in accordance with the invention. As shown by dotted line in Figure 28, information services processor (ISP) 16 is preferably located at the cable head end with system manager 12, HEC 14 and the signal scramblers. However, those skilled in the art will appreciate that all of the head end equipment need not be located at one site.

EPG data is supplied from one or more local or remote EPG suppliers 18 via a satellite link, modem link or other communication link to an RS-232 port of ISP 16. Similarly, text data from one or more text channel suppliers 20 is provided via a satellite link, modem link, or other communication link to another RS-232 port of ISP 16. In preferred embodiments, ISP 16 has a plurality of identical RS-232 ports for accepting data from a plurality of EPG suppliers 18 and text channel suppliers 20.

Also, as shown, one of these RS-232 ports can be used for a control link to HEC 14 as well. ISP 16 manages EPG and text source databases in response to control signals from HEC 14 in order to provide EPG data and/or text channel data to selected viewers.

HEC 14 also provides control data directly to the viewer's set top box via an RS-485 output port. Preferably, the control data from HEC 14 can include text channel definition transactions as well as EPG definition transactions for instructing the set top box at which frequency to tune for the EPG data and the like. The control data may also include software for downloading into the viewer's set top box for reprogramming the viewer's set top box as necessary. The control data from HEC 14 can be inserted into the vertical blanking interval of the selected cable television signal by daisy-chained scramblers 22, 24 and 26 using known in-band techniques, although the control data from HEC 14 may also be modulated on an out-of-band carrier or an in-band audio carrier for transmission as. Preferably, scramblers 22-26 are daisy-chained so that the scramblers may be addressed individually or globally.

Similarly, EPG data and text channel data from ISP 16 are provided to the viewer's television set top box via an RS-485 output port of ISP 16. EPG data and text channel data are similarly inserted into the vertical blanking intervals of selected cable television signals by EPG scrambler 28 and text channel scramblers 30 and 32, respectively. Scramblers 22-32 may insert the control data, EPG data, and text channel data into other portions of the video signals such as the horizontal blanking intervals or else replace the video entirely. Typically, the number of scramblers depends on the number of premium channels for which scrambling is used. Preferably, EPG scrambler 28 and text channel scramblers 30 and 32 are identical to control data scramblers 22-26 and are similarly daisy-chained for individual or global addressing. As shown in Figure 28, scramblers 28-32 receive a single serial data channel which carries the combined EPG data and

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text data and display control transactions, as described in more detail with respect to Figure 29) for all data streams in use. Each scrambler is also equipped with memory for storing a predetermined amount of this data in an internal memory so as to minimize the number of database accesses. Preferably, scramblers 28-32 have internal memory sufficient to store a significant number of transactions. For example, scrambler 30 may have enough internal memory to score a day's sports scores for display on a sports text channel. The data received and stored in scramblers 28-32 is preferably in RS-485 format, and the protocol in a preferred embodiment is SDLC. All data transactions to scramblers 28-32 are sent on individual data streams specifying the target scrambler (station addresses in SDLC protocol), and the control data is sent on a global data stream which is filtered in the scramblers 28-32 based on the address of the scrambler so that the data streams can be configured by a transaction from ISP 16. The individual EPG data and text data streams are preferably generic in the scramblers so that they can be allocated as desired. Preferably, scramblers 28-32 have baud rates of at least 9600.

Preferably, the subscriber's set top box is a set top box 34 which comprises an EPG memory 36 for storing the EPG data from ISP 16. For example, EPG memory 36 may store one or two weeks of EPG data for selective access by the viewer via a menu of the set top box 34. This menu preferably allows the viewer to scroll through the EPG data stored in EPG memory 36 using the key pads of the viewer's television remote control device. Set top box 34 may also comprise a nonvolatile template memory 38 for storing the template in which the EPG data is to be inserted for display to the viewer on the viewer's television 40. In this manner, a

video signal containing the template display data need not be continuously retransmitted to the set top box 34, thereby saving more bandwidth. Instead, the EPG data only needs to be updated every 30 minutes or when there is a program change. Of course, different set top boxes 34 may have varied amounts of memory and processing capabilities for such purposes in accordance with the acceptable memory costs during manufacture of the set top box 34.

As shown in Figure 28, set top box 34 may also comprise a text data memory 42 for storing a page of text data for presentation to the screen. Thus, while one page of text data is displayed to the subscriber, the next page of text data may be loaded into the text data memory 42.

ISP 16 manages the flow of text data and EPG data from the data service provider to the viewer's set top box 34. ISP 16 manages this data by accepting data only from one or more authorized text data and/or EPG data sources, processing the text data and EPG data in its internal database manager, and formatting the processed data into a common data transaction format for output to the scramblers for transmission to the set top box 34. Provision of EPG data and text data to the subscribers is controlled by the head end controller 14 via the control link.

One example of a suitable ISP 16 is an IBM PS model 7546 personal computer with a plurality of RS-232 serial input ports for EPG data and/or text data inputs and at least one RS-485 HDLC serial link at its output of the type used by HEC 14. As shown in Figure 28, the control link can be a single RS-232 serial port. The hardware and software components of ISP 16 are then configured as illustrated in Figure 29.

One embodiment of ISP 16 is illustrated in Figure 29 as a plurality of RS-232 ports which provide a common interface

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for the EPG data and text channel data asynchronously
provided by the EPG supplier(s) 18 and text channel suppliers
20. The EPG data and text channel data is transmitted to ISP
16 via a satellite link (when the interface is operated in
simplex mode) or by modem (when the interface is operated in
half duplex mode). Preferably, the data is transmitted at a
baud rate of at least 1200.

ISP 16 functions as a "gate keeper" which only allows
access by authorized data sources. Accordingly, when ISP 16
receives a message from an EPG supplier 18 or a text channel
supplier _0, it first checks the data for authorization. If
that supplier is not authorized, the data is ignored. When
the supplier is authorized to access ISP 16, ISP 16 performs
the requested action and returns a command response message.
If the communications link is simplex, the response is
ignored. In this manner, access to ISP 16 can be limited by
authorization codes, but as will be described below, access
is also limited by whether the data provider provides EPG
data or text data in the transmission protocol expected by
ISP 16.

Messages sent between an EPG supplier 18 or a text
channel supplier 20 and ISP 16 can be formatted to include a
start of text byte, a data block of ASCII characters,
checksum bytes and an ASCII carriage return. This format is
used in commands sent to ISP 16 from the data suppliers as
well as in responses sent to the data suppliers. The
checksum can be a two byte CRC of all bytes in the message
field beginning with the first character following the start
of text character up to but not including the checksum field.
The checksum is transmitted in the message as the hexadecimal
ASCII representation (four bytes) of the CRC computation.

The data blocks can be configured differently depending upon whether the input data is EPG data or text data.

EPG data from the EPG supplier 18 can be formatted in accordance with an EPG command set including, for example, a Define Program Command which is used to identify all data relating to a single program, a Define Category Command which is used to establish a category for identifying different types of programs, and a Delete Category Command which is used to delete an unused category to make room in the database of ISP 16 for new programming categories. The EPG data may be formatted on a per program basis by these commands.

Delimiter characters can be used for variable length fields such as the title and program description blocks to identify the length of the field. For example, a NUL (0 hexadecimal) means the field is null, SOH (I hexadecimal) means the field is valid, and ETX (31 hexadecimal) means the end of the current record.

Once data transmitted with a Define Program Command is stored in an EPG database of ISP 16, the EPG data is formatted into transactions for transmission to the set top box 34. This command may also be used to update a program definition since it will overwrite a corresponding entry in the EPG database of ISP 16.

ISP 16 may respond to such commands from the EPG supplier 18 by sending an appropriate response such as: no error (normal response), service provider not found (not authorized), type of service not found (not authorized), category ID riot found, unrecognized command, checksum error, insufficient disk space, and the like. Other EPG commands and command responses may be provided as desired.

The text channel data can originate from many different
text channel suppliers 20 and arrive at the ISP 16 through
different communications links such as satellite, dial up
modem, direct connect modem or with a direct connect to the
system manager 12.

ISP 16 can include a plurality of databases and database
managers. As shown in Figure 29, there may be two types of
databases maintained in ISP 16---one type for EPG data and
one for text channel data. The EPG database is designed to
collect data from each EPG supplier and to sort each EPG
program record by channel and time of day. A separate
database is created for each text channel for collecting text
data from the associated text channel supplier 20 and
formatting the received text data for transmission on
individual text channels using the techniques to be described
below. Each database that is created is identified by the
service provider and type of service codes listed in the
Define Program Command for use in the control link commands
provided to ISP 16 from HEC 14.

As shown in Figure 29, a received command is checked
for its command code, the service provider, type of service
and authorization code, as appropriate, by router and
formatter 43. If the command is from an unauthorized data
source, the subsequent data is ignored. However, if the
received data is from an authorized supplier, router and
formatter 43 routes the data to the appropriate database
within ISP 16. For example, if EPG data is received, it is
routed via EPG database manager 44 to EPG database 46.

In one embodiment, EPG database manager 44 sorts the
received EPG data by channel and time of day and stores the
received EPG data in the appropriate location in EPG database
46 for later recall. EPG database manager 44 may also

perform garbage collection on the EPG database 46 as records
are deleted. EPG database manager 44 may also call a data
compression software routine such as the Huffman Compression
Algorithm which, as known to those skilled in the art, maps
more frequently used characters to fewer bits than the usual
eight bits used in normal ASCII, while giving the less
frequently used characters more bits. The number of bits
used for a character is based on its probability of appearing
in the data stream. Huffman encoding is described in detail
in an article entitled "Lossless Data Compression", Byte,
March, 1991, pp. 309-314, incorporated herein by reference.
Such a routine is desired to maximize storage efficiency at
EPG database 46. Similarly, each text database manager can
store the text information in the associated text database
and performs data compression.

Router and formatter 43 and database managers 44, 48 and
52 are all controlled by configurator 56, which is, in turn,
responsive to control data from HEC 14. Configurator 56
responds to control commands from HEC 14 to provide updated
authorization information to router and formatter 43 for
comparison with the incoming data and for adding/ subtracting
database managers and databases and the like as EPG suppliers
18 and text channel suppliers 20 are added and subtracted
from the system.

Access to ISP 16 is can be carefully controlled through
the use of authorization codes. In addition, ISP 16 can
maintain control over the information services provided to
the viewer by storing the EPG data and text data in a
particular format in the appropriate database within ISP 16.

Referring now to Figure 30, the EPG database key can be
a combination of the date and time field and the channel
number from the EPG data. Following these fields are the

duration field, the repeat field, the program rating field,
the program category field, the critique field, the
attributes flag field, the program traits flag field, the
text data compressed flag and lastly the text data. The text
data field may further consist of several optional subfields
with a delimiter between each field.

EPG database manager 44 can access the EPG database 46
through shared library routines such as add a record, delete
a record, read a record, and the like. As the EPG database
46 is used. it can be fragmented as records are added and
deleted, and as a result, EPG database manager 44 may further
include garbage collection routines for periodically
performing the garbage collection function on the EPG
database 46. The text databases are similarly configured
except that garbage collection is not necessary.

In one embodiment, EPG transaction formatter 58 reads
the database records of EPG database 46 and formats them to
program-based transactions having a predetermined number of
bytes which are transmitted to the EPG scrambler 28 for
insertion into the vertical blanking interval of a video
signal and transmission to the set top box 34. These
transactions are then sent via a transaction arbitrator 64 to
the EPG scrambler 28 shown in Figure 28 for insertion into
the appropriate video channel.

The transactions from transaction arbitrator 64 can be
output to a single RS-485 output port of ISP 16 which is
connected to multiple scramblers of the type used to scramble
premium cable channels. The transactions are segmented into
EPG data and text data streams for transmission to the EPG
scrambler 28 (if the transaction includes EPG data) or to the
text channel scramblers 30 and 32 (if the transaction
includes text data).

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In one embodiment, the EPG transactions generated by EPG a transaction formatter 58 are formatted into SDLC frames as noted above. A sample SDLC format for the EPG transaction data is shown in Figure 31. In Figure 31, the beginning flag delineates the beginning of the SDLC frame, the station address delineates the scrambler to be addressed, the control byte is a command code that defines what is to be processed, the information field contains the EPG data formatted as in Figure 30, the frame check contains the CRC for all data between the beginning and ending flags, and the ending flag delineates the end of the SDLC frame. A transmission from EPG transaction formatter 58 will address a specific data stream and a response from the EPG scrambler 28 will identify its data stream in the station address location. As noted above, such transmissions may or may not require a response from the EPG scrambler 28.

The EPG transactions typically include an Add EPG Block command including a byte specifying that the following data is from the EPG data stream, a control code byte specifying, for example, whether a reply from the scrambler is expected, two bytes setting forth the EPG data block number, a flag setting forth whether the EPG data is Short Term or Long Term data, the number of transactions which make up the EPG data block, and the actual transactions. EPG transaction formatter 58 may also generate a Delete EPG Block command which specifies that the data is to be deleted from the EPG data stream, the control code byte, and the EPG block number to be deleted.

Figure 32 illustrates a flow chart for one embodiment of software that can be used and embodied in EPG transaction formatter 58. As shown, the software starts at step 500 and gets the system time and date from the ISP system clock 63 at

step 502. An expired EPG data block is then deleted from the
memory of the EPG scrambler 28 at step 504. An expired EPG
data block is defined as a data block representing a program
which has been completely aired prior to the current system
time or a program which was aired before the time window used
for the EPG. At step 506, current EPG data blocks having a
time and date within the EPG time window are read from the
EPG database 46. The current EPG data blocks are then
formatted into Add EPG Block commands and associated
transactions at step 508. A block/time map of EPG
transaction formatter 58 is then updated at step 510. The
block/time map preferably stores the time that each EPG data
block was sent to EPG scrambler 28. The transactions
representing the EPG data are then transmitted the EPG
scrambler 28 at step 512. EPG transaction formatter 58 then
waits at step 514 for the next EPG update (which should occur
when the system time enters a new half hour) or the next EPG
change (which may occur at any time). Upon receipt of such
an update or change, control returns to step 502. Text
transaction formatters 60 and 62 similarly generate text
transactions for the text data, which as noted above, is
defined on a per screen (rather than per program) basis.
Hence, an Add Text Screen command is similar to an Add EPG
Block command except that the text channel number and screen
number are provided in place of the EPG block number and
Short Term/Long Term data bytes. The text transaction
formatters 60 and 62 may also request the time from the
scrambler so that proper pagination may be maintained.

Figure 33 illustrates a flow chart for one embodiment of
software that can be used and embodied in text channel
transaction formatters 60, 62. As shown, the software starts
at step 600 and reads a text screen record from the text

database 50 or 54 at step 602. At step 604, the text screen
is formatted into Add Text Screen transactions for
transmission to the text channel scramblers 30, 32 at step
606. Preferably, such transactions are formatted such that
the display characters are sent as display commands rather
than as separate characters for every display coordinate of
the text display screen. Then, at step 608, text transaction
formatter 60, 62 waits a period of time specified by system
manager 12 (if auto-pagination is used) before the next text
page is formatted and transmitted to the text channel
scramblers 30, 32. At the end of this period of time,
control returns to step 604 and the next text screen record
in the text database 50, 54 is formatted for transmission to
text scramblers 30, 32 for insertion in the vertical blanking
interval of a particular video signal.

Text data can be passed to the screen by sending a
separate character for each display location of a page. In
other words, if a text screen comprises 16 lines and 4
characters per line, a text screen is represented by sending
384 (24XI6) characters, one for each display location for
that display screen. A blank space character is sent to
indicate that no character is present in a particular text
screen location.

In one embodiment, the text data is transmitted to the
screen along with appropriate commands for controlling the
display of the text data. For example, a first display
command in a sequence identifies the following data as text
data and instructs the set top box 34 to fill the television
screen with a blue background or some other background or
template over which the text will be displayed. The text
data is then converted into a series of commands which
together identify the separate screens of text. As noted

above, the text data is grouped on a per screen basis, which allows the appropriate delay mechanism to be incorporated into the display commands to provide the necessary delay between the presentation of respective text screens.

For this purpose, transaction formatters; 60 and 62 can include software for scanning the text data for actual characters, skipping extra spaces in the text data, and grouping the actual text for transmission in transactions of a designated size which will fit in the vertical blanking interval of a field of a video signal. Since spaces are eliminated, the display commands include a coordinate specifying the row and column address of the first display character on the screen and a number of contiguous characters follow that character in the same transaction until the transaction is filled or a number of successive spaces are encountered.

Attribute information such as underline, blinking, or luminance inversion associated with the characters may also be transmitted using these display commands. These display commands are used to read the text data for a text screen from the appropriate database, and at the end of the text data for a text screen, a display command is transmitted to indicate that all data for that text screen has been transmitted. The transaction formatter 60, 62 also includes a wait loop or "timeout" command at the end of the transmission which builds in a delay (on the order of 7 seconds) which gives the viewer sufficient time to view a text screen before the text data for the next text screen is displayed, thereby providing auto-pagination of the text screen.

Auto-pagination permits the viewer to automatically advance from one text screen to the next without any

intervention by the viewer. In accordance with the auto-pagination scheme of the invention, the cable operator can specify the time duration between screens and forward this information to the transaction formatters; 60, 62. Then, during operation. when the viewer selects a text channel, the current page of text data is displayed by extracting the selected text channel data from the vertical blanking interval of the video signal in which it is inserted and mapping that text data to a channel of the viewer's television which is designated for display of that text channel. The next screen of text data will be displayed after a predetermined delay which gives the viewer sufficient time to read the displayed text data for the current screen (approximately 7 seconds). This technique could replace the commonly used "barker" channel which uses a computer to generate text data which is then transmitted as a complete video channel over the cable television system.

Configurator 56 can respond to control commands from HEC 14 to provide updated authorization information to router and formatter 43 for comparison with the incoming data and to add/subtract database managers and databases and the like as EPG suppliers 18 and text channel suppliers 20 are added and subtracted 57 from the system. The control link between HEC 14 and configurator 56 can be used to report the status of the ISP 16 to system manager 12. Additionally, the control link may accept text data from system manager 12 for displaying system messages and the like.

In one embodiment, the interface between configurator 56 and HEC 14 is an RS-232 port with a data format fixed at, for example, 9600 baud. All control data is preferably transmitted as ASCII characters. Upon receipt of a message from HEC 14, configurator 56 checks the data, performs the

requested action. and returns a command response message in a message format of the type described above for communications between router and formatter 43 and the EPG and text channel suppliers. Sample commands sent from HEC 14 to configurator 56 over the control link include a Set Date and Time command (for synchronization purposes), Request Configuration commands, Request Status commands, Get Category Record commands, Scrambler Control commands, and Database Control commands.

In one embodiment, during operation, ISP 16 monitors all input ports data from the EPG and text data service providers and builds a list of all available EPG and text data services. This list is sent to the system manager 12 using a Request Configuration command. This command specifies the available service providers, the type of service (EPG or text data) from each provider, the communications port associated with each service, the scrambler address or data stream (EPG or text data) for each service, the authorization code from the supplier for each service, the time and date of the last update from the service provider, the time and date of the last update to the scramblers, the time and date of the latest EPG data in the EPG database, and the like. Such information is provided to the system manager 12 for each service provider when this command is given.

The Request Status command can contain flags indicating whether there are errors present in the error log and if the category list has changed since the last Request Status command was received. Get Error Record and Get Category Record commands may then be used to extract the error and category information.

In one embodiment, configuration commands are separated into EPG and text service configuration commands. A

Configure EPG Service command specifies the service provider, the type of service, whether the service is to be enabled or disabled, the authorization code from the EPG supplier 18, the scrambler data stream for Short Term data, the scrambler data stream for Long Term data, the length of the Short Term data in hours (1-255), and the length of the Long Term data in hours (1-4096). The Configure Text Service command specifies the service provider, the type of service (weather, sports, and the like), whether this service is to be enabled or disabled, the authorization code from the text channel supplier 20, the scrambler address or data stream for the text data, the channel number, and the pagination delay time in seconds) before the next page of text data is to replace the current page of text data on the screen for auto-pagination.

The scrambler control commands can include, for example, a Rebuild Scrambler Memory command which is used when a scrambler replaced and needs data to be reloaded in its memory and a Scrambler Configuration command for specifying the amount of scrambler memory in kbytes.

In one embodiment, the database control commands include, for example, a Clear Database command which is used to clear the database associated with a particular service and a Delete Database command which is used to delete the database associated with a particular service. Other database control commands such as a Download Category Map command may also be provided for establishing a list of the specified categories of program data in the EPG data.

Figure 34 illustrates one embodiment of a set top box 34 that can be used with the present invention. As shown, set top box 34 includes EPG memory 36, template memory 38, text page memory 42, a set top box 700, and a set top processor

702 which reads commands from the vertical blanking interval
of the incoming video signal and performs the appropriate
action. For example, if the incoming command is a text
channel definition or EPG definition command from HEC 14, the
appropriate update of bit map 704 is performed. Similarly,
if the incoming command is a display command including EPG
data, that data is stored in EPG memory 36 and is displayed
with the template stored in template memory 38 when the user
makes a menu selection via television remote control unit 706
and remote receiver 708 requesting display of the EPG data.
The template data may be sent as part of EPG display commands
if no template memory is provided. On the other hand, if the
incoming command is a display command including text data, a
page of that data is stored in text page memory 42 for
presentation to the display a page at a time. The text page
memory can be automatically updated every few seconds by
virtue of the delay built into the display commands from the
text formatters 60, 62 if auto-pagination is enabled.
Alternatively, the user can be allowed to manually access the
text data in the memory. If manual access is provided, it is
preferred that the text page memory hold at least the
currently displayed text page, the previous text page and the
subsequent text page in order to give the user the ability to
scroll through the text data In either case, set top
processor 702 preferably has the ability to request the next
text page while the current page is being displayed so that
the next text page is already loaded for display at the end
of the screen delay time. The selected text, EPG or video
signal is then modulated at modulator 710 for display on
television screen 40 at the channel specified in bit map 704.

Bit map 704 of set top processor 702 of the set top box
34 maps the received text information to the designated cable

channel for display by designating the frequency that must be tuned by box 700 to receive the desired text data. This information is received in the aforementioned text channel definition transactions from HEC 14. For example, the viewer may specify via television remote 706 that she wishes to view a sports text data channel which her program guide indicates to be available by tuning the set top box 34 to channel 181. Set top processor 702 then checks bit map 704 for channel 181 to determine that it must tune the frequency for channel 29 in order to extract the sports text data for the viewer's channel 181 from the vertical blanking interval of channel 29, set top processor 702 ten sets set top box 100 to tune channel 29 but the video signal for channel 29 is not displayed. Instead, the video screen is blanked by set top processor 702 and the text data extracted from the vertical blanking interval by set top processor 702 is displayed. Any necessary descrambling of the received video is performed by set top processor 702. The viewer thus perceives that many more "virtual" channels are available even though a separate video channel was not used to transmit the text data.

In one embodiment of the present invention, illustrated in Figure 42, electronic content is tagged and aggregated at a server and becomes electronic content with targeted information. Suitable electronic content includes but is not limited to, advertising, news segments, video programs, audio programs, WEB pages, and the like. The electronic content with targeted information is send to a broadcast server and broadcast widely. Set top box 34 has created profiles representing different people in the household. Set top box 34 matches the tags in the broadcast stream with the profiles created and determines which of the tagged content should be downloaded. A subset of all of the content that is broadcast

that are relevant to the personalities in the household are downloaded and displayed to the user.

For example, set top box 34 can be used to match the tags in the broadcast stream with a demographic profile of a viewer previously created and determine which of the tagged content should be downloaded. An individual viewer receives from set top box 34 only. Set top box 34 matches the tags in the broadcast stream with the demographic profile of the viewer created and determines which of the tagged content should be downloaded.

Some example of demographic characteristics include, but are not limited to, a user's gender, race, age and income. The output of the analysis of viewing habits of the representative sample provides a basis for determining demographic characteristics of the individual user.

As shown, set top box 34 reads commands of the incoming tagged and aggregated electronic content and performs the appropriate action. For example, if the incoming command is a text channel definition or EPG definition command from HEC 14, the appropriate update of bit map 704 is performed. Similarly, if the incoming command is a display command including EPG data, that data is stored in EPG memory 36 and is displayed with the template stored in template memory 38 when the user makes a menu selection via television remote control unit 706 and remote receiver 708 requesting display of the EPG data. The template data may be sent as part of EPG display commands if no template memory is provided. If the incoming command is a display command including text data, a page of that data is stored in text page memory 42 for presentation to the display a page at a time. The text page memory can be automatically updated every few seconds by virtue of the delay built into the display commands from the

text formatters 60, 62 if auto-pagination is enabled.
Alternatively, the user can be allowed to manually access the
text data in the memory. If manual access is provided, it is
preferred that the text page memory hold at least the
currently displayed text page, the previous text page and the
subsequent text page in order to give the user the ability to
scroll through the text data. In either case, set top
processor 702 preferably has the ability to request the next
text page while the current page is being displayed so that
the next text page is already loaded for display at the end
of the screen delay time. The tagged and aggregated
electronic content is then modulated at modulator 710 for
display on television screen 40 at the channel specified in
bit map 704.

Bit map 704 of set top box 34 maps the received tagged
and aggregated electronic content to a designated cable
channel for display. Set top processor 702 then checks bit
map 704 for channel 18 1 to determine that it must tune the
frequency for channel 29 in order to extract the. Any
necessary descrambling of the received tagged and aggregated
electronic content is performed by set top processor 702.

MULTIPLE VIEWER PROFILES IN A MULTI-VIEWER HOUSEHOLD

The present invention also provides a mechanism to
automatically create multiple profiles corresponding to
multiple users with or without any information being
explicitly providing by the users about themselves.

Fig 35 shows an embodiment of the invention that causes
the automatic creation of multiple profiles and automatic
identification of profiles when they are active on the
device.

In one embodiment, number of profiles to be created is determined initially. Several methods may be used to determine the number of profiles. In one embodiment of the current invention the number of profiles is optimally determined by applying the Minimum Message Length (MML) criterion. The process of applying MML criterion for determining the optimal number of clusters in described in reference (ref..). In one embodiment of the current invention, a user of the device explicitly specifies; the number of profiles to be created.

The system monitors user interactions with the device. The user interactions may include but are not limited to channel change requests, requests to view more information, configuration of device parameters, requests to performs recording or deletion of programs from a storage device. All actions due to user interactions are recorded in a history database that stores history of viewer actions. Data records in the history database describing viewer action can be of different formats. Figure 37a shows one of the possible formats for the data record. Data records may contain information about the action, time at which the action occurred, and some parameters that further describes the action. In one embodiment of the invention, only actions matching certain criteria are recorded in the history database. For example, all user action about watching channels can be ignored if the duration of watching is less than a configurable threshold, or all user action about watching a particular channel like preview channel can be ignored. In the default usage of the device, the user will not be identifying himself or herself during each usage session. A usage session in this context can be the period during which there are user activities between two periods of

inactivity, or the period during which the device is used
between two periods during which the device is not in use.
It will be left to the device to determine who the actual
user is, in order to provide a very personalized environment
to the user. In such a scenario the user action records will
not contain any information about who the user is. In one
embodiment of the current invention, the user can identify
himself or herself explicitly for all or some of the usage
sessions by using some mechanism provided by the system.
These mechanisms may include pressing a sequence of keys, or
choosing a user name from a menu and logging-in as that user.
In this embodiment of the invention the user can identify
himself or herself during certain sessions and may choose not
to identify himself or herself during some other sessions.
In the case where the user identifies himself or herself
certain user action records can have the user name or some
other identification data as a parameter which specifies that
a user was togged-in for the session from which the user
action record was generated.

By analyzing the user action history database that was
generated for a period of time, the current invention
provides a mechanism to create multiple profiles
automatically. Each of these profiles may correspond to the
entire preference of a single user, a group of related
preferences of a single user, a group of related preferences
of a group of users or the entire set preferences of a group
of users. The mechanism for creating multiple profiles is
described in figure 36.

Sets of consecutive user action records are grouped
together to form usage pattern records. Usage pattern
records can be in the form of arrays of user action records.
Only user actions that occur contiguously are grouped

together in a single usage pattern record. The usage pattern
records can be formed using many methods, some of which are:

Grouping together all user action records that are in a
single usage session into a single usage pattern records.
This is represented graphically in figure 38a.

Grouping together all user action records that are in a
single usage session into a one or more usage pattern records
where each usage pattern record has a predetermined number of
user action records. This is represented graphically in
figure 38b.

Grouping together a predetermined number of consecutive
user action records in a usage session into one or more usage
pattern records where each usage pattern record has a number
of user action records which overlap with some of the user
action records in an adjacent usage pattern record. This is
represented graphically in figure 39.

Each usage pattern record is mapped to a point in an N-
dimensional space, each axis of this N-dimensional space
representing a parameter that is of significance in
identifying multiple profiles. The N-dimensions for this
space are called cluster-dimensions. The parameters for this
N-dimensional space are chosen either manually by people
skilled at identifying the most significant parameters in
identifying multiple profiles, or automatically by
identifying the aspects of profiles that differs
significantly between profiles. In one embodiment of the
current invention a set of these parameters are identified
and configured as the apparatus is configured during
initialization, and a new set is added periodically by
looking at aspects which differ in the multiple profiles that
are stored in a device. A wide variety of combinations of
initial parameters may be used. In one embodiment these

initial parameters are the channel names in a channel line up
and viewing times. In the embodiment, these initial
parameters are possible values of program description fields
of television programs. In one embodiment the rate of
channel change is also one of the parameters. The mapping of
the usage pattern record to a point in the space defined by
cluster-dimensions can be done by many methods. One method
determines the quantity of a particular characteristic which
is defined by a clustering parameter, exhibited in a usage
pattern record, e.g. number of channel changes in a usage
pattern, and uses this as the value of the axis for the
corresponding dimension. One method determines the rate of
consumption of a particular characteristics in a usage
pattern record, e.g. rate of consumption for "NBC" in a
usage pattern record is .5 which indicates that programs on
"NBC" were watched 50% of times during the period of this
usage pattern record.

All the points in the space defined by cluster dimension
are clustered into a number of clusters using standard
clustering algorithms. Any clustering algorithm can be used
to perform the clustering. In one embodiment EM clustering
is applied to group the points in the cluster-dimension space
into a predetermined number of clusters. The number of
profiles being created decides the number of clusters formed.
Anyone skilled in the art of artificial intelligence and
clustering, especially EM clustering, will be familiar with
these clustering techniques. Each cluster formed as a
resulting of the clustering represents a single profile. The
clustering process also provides the mixture weights for each
of the clusters as one of the outputs. The mixture weight
for a cluster can be used to compute the percentage of time

the profile was active, of the total amount of time for which the device was used.

In one embodiment of the present invention, the clustering is performed periodically using the user actions records accumulated in the history database. In one embodiment, user action records are periodically removed from the history database based on certain criteria such as the age of the record, size of the record, relevancy of the record etc.

The current invention also provides a mechanism to predict profile that is active at any given time. Figure 40 illustrates the method for identifying the profile currently active on the device. Current user actions are monitored and user action records are created. The most recent user action records are used to create a usage pattern record. The usage pattern record is mapped to a point in the cluster dimension. Using the Information about clusters representing multiple profiles, the, probability of each of the clusters being active given the usage pattern is computed. This is computed by using Bayesian Probability theory that can be used to compute the posterior probability using the prior probability and mixture weights. The probability of a cluster being active is computed using the probability of the usage-pattern record given the profile (P/usage_pattern profile), the probability of the profile being active and the probability of the usage record occurring. The mathematical representation for the Bayesian Probability theory in the current context is given below

P(profile/usage_pattern) = P(usage_pattern, profile) * P(profile)) P(usage_pattern)

In this equation probability of usage pattern record occurring given profile (P(usage-pattern, profile)) can be

computed by knowing the probability distributions governing the clusters. In one embodiment, the cluster probability distribution can be assumed to be the Gaussian probability distribution, so that the P(usage_pattern profile) can be computed using the cluster center and cluster variation. Cluster center and the cluster variation are the output generated by the clustering process performed for generating multiple profiles.

In one embodiment, switching the device on can be one of the user actions recorded and "time of usage" one of the clustering dimension. In this .embodiment, as soon as a user switches the device on, the probability for any cluster being active can be determined, even with out any further user actions. As the user performs more user actions, the current usage pattern record is refined to include more user action records and the probability of profiles which may be active is refined with the addition of each new user action record. As more user action records are added to the current usage pattern, a set of the oldest user action records may be removed from the current usage pattern record. This process ensures that the effect of individual user actions in the identification of active profiles decreases as time passes.

In one embodiment of the current invention, the clusters generated by the clustering procedures are used to create multiple profiles using a method described in Figure 41. In this embodiment, the clusters are used to compute the probability of each clusters being active during the period of each usage pattern record. User preferences for each profile are created using processes described previously using the user actions weighted by the probability of the corresponding cluster being active.

TARGETED ADVERTISEMENT DELIVERY

With reference now to Figure 43, in a preferred embodiment of the present invention used to deliver advertising content to specifically targeted viewers based upon their individual viewer profile, the broadcast network amasses content from the many different content providers and combines it at a network broadcast head end 29 into a broadcast signal that is transmitted to, and received by, the television control system 2 of the present invention. The control system 2 sorts through the content received from the broadcast network based upon the profiles of the different viewers in the particular household, compiles lists of preferred programs available to each user, records and stores programs of interest, and makes the programs available for viewing when required. Equally important, the control system 2 receives and sorts through various advertising content and stores the content most relevant to the viewers in the house hold based upon their demographic profiles and the target audience of the advertising content.

With greater particularity, and as shown in Fig. 43, content providers include EPG suppliers 18, text channel suppliers 20, conventional programming suppliers 23, and alternative content suppliers 25. As described below, alternative content refers to highly targeted programming that may be delivered through the use of a control system 2 as described herein. Conventional programming encompasses all types of programming currently available and including, but not limited to, movies, news, sport events, educational programs, pay-per-view shows, and shopping channels. Advertising content suppliers 19 provide promotional material such as short video clips or graphical and text information to programming suppliers 23 for inclusion in their

conventional programming content, in a manner familiar to TV viewers worldwide. However, in a novel method of delivering advertising content uniquely available through the use of the present invention, advertising content may be supplied to alternative content suppliers (see discussion below) and may also be profiled through a profiler 21 to develop meta data descriptive of each individual advertising message. As discussed elsewhere in the specification, the meta data refers to demographic characteristics that describe the viewers to whom each advertisement is specifically targeted.

The profiler 21 may be a software based system or may rely upon human intervention to watch and analyze each advertising message and develop meta data descriptive of the advertisement. Alternatively, the advertising content suppliers 19 may provide this information along with the advertisement. The meta data is developed based upon the parameters of interest to the clients for whom the ads are developed, and will typically include the age, gender, ethnic background, education, profession, and other demographic information related to the viewer. The meta data will thus describe the viewers to which each advertising message is targeted in terms of the viewers' demographic information as defined by the parameters mentioned previously. The meta data thus generated is then appended to each advertisement and the thus-tagged advertisements are provided to the broadcast network for inclusion in the broadcast signal.

The tagged advertisements will preferably be provided in a plurality of channels, wherein each channel may carry a specific type of advertisement in terms of the target audience. Thus, each channel may be defined according to one demographic parameter or an often recurring combination, e.g. a channel with ads for men, a channel with ads for women, a

channel with ads for male sports fans, etc. Alternatively,
each channel may carry a stream of all types of ads, wherein
each type of ad is present in a ratio dependent upon the
demographic parameters to which it is targeted. Thus, ads
targeted to male sports fans on weekend afternoons will be
more numerous than ads targeted to young children, because of
the large number of sports events broadcast at such time and
the high probability that young children will be playing
outside rather than watching TV indoors at such times.
Although providing tagged advertising content via a plurality
of channels is not a requirement of the invention, it is
believed that the sheer amount of advertising content
available will require multiple channels as a practical
matter. Furthermore, providing channels in a pre-sorted
manner may reduce the amount and complexity of the sorting
carried out by the control system 2 (as more fully described
below).

Also as shown in Fig. 43, the signal broadcast by the
network may further include information provided by the
administrator of the service provided by the invention, e.g.
Metabyte Inc., the assignee of this application. As described
in more detail elsewhere in the application, this information
may include updates of the software of the control system 2.

With continued reference to Fig. 43, the network
broadcast signal is transmitted to, and received by, the
control system 2. The broadcast signal may be analog or
digitally encoded, and may be transmitted via cable,
satellite, telephone line, or any other practicable manner.
In view of the large number of channels typically available
and the state of the art, practical considerations will most
likely dictate that the network signal be broadcast in
digital form, in which case both the network head end 29 and

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the control system 2 will need to incorporate ADC and DAC
circuitry, in a manner very well known to those skilled in
the art. Furthermore, it is understood that the control
system 2 will need to incorporate channel tuning circuitry
that, although not shown in the figure, will be necessary to
separate the numerous signals multiplexed in the broadcast
signal and select any one of these signals (i.e. channels) as
necessary.

Once received by the control system 2, the broadcast
signal is supplied to various components of the system. The
program switch 114 responds to the viewers input as provided
via a remote control or similar unit to select the desired
channel and direct the channel signal to the TV monitor 108.
As described previously, the preference agent 110 monitors
the viewing selection of the various viewers using the
control system 2 and creates viewing profiles of each viewer
that are stored in the preference database 116. Based upon
these profiles, the preference agent 110 sorts through the
incoming programming content as described in the EPG
information to compile lists such as "Top 10" lists of
viewing choices available at any given time to each viewer,
and directs the recording manager 112 to record the top-
ranked program being broadcast at any given time (including
any programs selected by the viewers for recording) and store
it in the stored programs memory device 35.

The preference agent further contains software that
allows it to create a demographic profile for each viewer,
based upon the viewing profile of the viewer and certain
algorithms or associative rules. These algorithms may be
adjusted over time as the model employed by the system
administrator 27 is enhanced and its accuracy improves. To
this end, the system update information channel included in

the broadcast signal may include periodic software updates, including new preference database parameters that may need to be included at the request of the advertising suppliers 19. Thus, in one embodiment the control system 2 of the invention may be remotely upgraded to meet any new demands that may arise as advertising content providers become familiar with the system and the process of custom tailoring narrowly focused, targeted advertisements. The demographic profile created for each viewer is stored in the demographic database 31, which resides in the control system 2 and thus ensures the viewers privacy.

The preference agent 110 also sorts through the advertising content streaming in through multiple advertising channels contained within the broadcast signal and, based upon the demographic profiles of the viewers and the meta data contained in each advertisement to describe the target audience for the particular advertisement, stores and/or causes the display of particular advertisements. The control system 2 may utilize any of a variety of methods to manipulate the advertising content, as described below.

In one embodiment of the invention, the advertising channels each carry the same type of advertising. The preference agent determines which viewer is watching TV at any given time and stores in stored ads memory device 33 those tagged advertisements that are targeted to the particular viewer. At appropriate times during the program that is being watched by the viewer, such as during the commercial breaks typically inserted in most TV programs, the preference agent directs the program source switch 114 to access the stored ads and play a selected advertisement on the TV monitor 108. If the program being watched by the viewer contains information regarding the length of the

commercial break, the preference agent may select stored ads of appropriate length to insert in the allotted time slot. The preference agent may further keep track of the ads that have been previously played to ensure that all stored ads are displayed equally. Alternatively, tagged ads may contain the desired number of times that the advertisement provider wants the ad to be aired during any given day, or perhaps the specific times at which the ad should be shown. Thus, after a number of ads having been stored, e.g. sufficient for a 24 hour period, the preference agent may review all of the stored ads meta data and develop a strategy for showing these ads to the viewer including when and how often.

Alternatively, the preference agent may cause a certain number of ads to be displayed and direct the recording manager 112 to record the selected program if the stored ads being displayed run longer than the allotted time slot for the commercial break. The control system 2 of the present invention can therefore manipulate the broadcast schedule of a program to a certain extent by modifying the amount of advertising content that the viewer is subjected to.

In another embodiment, the advertising channels may be operational for only a limited time during the day, typically at off-peak hours (e.g. 2 a.m.), during which all advertisements for the coming day may be downloaded and stored. Thus, an advertising channel may be turned on at a certain time and stream all advertisements to the control system during the space of an hour or two. Alternatively, a regular programming channel may suspend programming for an hour or two at a convenient time and supply the advertisements for the following day. In yet another alternative, a dedicated connection such as a phone line or

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an internet connection may be used for periodic downloads of advertisements.

In an alternative embodiment, multiple advertising channels carry a mixture of advertisements such that at any given time the preference agent has the option of selecting at least one advertisement targeted to the viewer from one of these channels. In this embodiment the control system need only to store one advertisement at any given time to ensure continuity between the program being watched and the advertisements. Thus, by way of example, the commercial break in the program may occur at a time that does not correspond to the beginning of an advertisement on any of the advertising channels. In this case, the advertisement stored by the control system is directed through the program source switch to the TV monitor while another targeted advertisement is concurrently stored for subsequent display. If the commercial break happens to coincide with the start of a targeted advertisement on any of the advertising channels, the preference agent can simply cause the program source switch to direct the particular channel to the TV monitor while another advertisement from another advertising channel is being stored.

In another embodiment, each regular programming channel can carry multiple, multiplexed versions of an advertisement. When a commercial break occurs, the preference agent selects the most appropriate version of the advertisement and directs it to the program source switch. This embodiment would require additional circuitry to de-multiplex the various versions of each add and apply the particular version selected by the preference agent to the program source switch.

The novel method of delivering targeted advertising that is provided by the invention is extremely advantageous to the advertising community. In one aspect, the invention allows greater freedom in producing advertisements because they no longer need to be appealing to as wide and varied an audience. Furthermore, because the alternative advertisements are delivered in real time, all viewers are reached by individualized advertisements at the same time, thus providing significant time savings in comparison with the prior art, wherein five different advertisements would require five different time slots during which to be broadcast. The cost savings thereby realized, especially during very popular events such as the Super Bowl, can be significant.

As mentioned above, preference agent 110 may sort through available channels to select the ten (or any other number) programs currently playing that most closely match the viewer's viewing profile. In addition, the preference agent may also build customized listings of future programs based upon the viewer's profile as well as any additional criteria specified by the user. In a preferred embodiment the user will have the ability to fully customize his viewing profile, including the values assigned to the different parameters that make up his or her viewing profile. In an alternative embodiment the user may even be allowed to specify what kind of advertising he prefers. Such a configuration would likely generate an alternative billing arrangement, whereby the user agrees to watch advertisements in exchange for the ability to specify the types of advertising he wishes to be subjected to and perhaps some sort of financial incentive.

Another novel possibility engendered by the present
invention is the creation of a 'personal channel' that is
always showing the most interesting program being broadcast
at any given time and/or previously recorded and stored
programs that were very close matches to the viewer's
profile. Thus, turning on to the personal channel will always
guarantee the viewer the most individualized, interesting
viewing experience available based upon the programs
broadcast during a certain preceding time period that the
viewer may specify. The personal channel may thus show a
collage of movies, news segments, sports events, and any
other programming content that was broadcast during the
preceding 24 hours and that matched the viewer's profile to
within a specified degree.

An additional element of control system 2 that may be
incorporated only in selected control systems is a privacy
filter 37 that deletes any personal information from the
demographic database and transmits this anonymous information
to the system administrator 27 for purposes of maintaining
and updating the model used to generate the demographic
database. Such models of the control system will require a
feedback line for transmitting the demographic information to
the system administrator, and in a preferred embodiment is a
telephone line or a dedicated internet line such as DSL,
cable, etc. The system administrator may offer financial or
other incentives to users to convince them to supply this
type of information. By carefully selecting users across a
wide demographic cross section, the system administrator can
use the information thus gathered to enhance the model used
to develop a viewer's demographic profile based upon his or
her viewer profile by comparing these users' actual

demographic data with the demographic profile developed by the preference agent.

Due to the narrowly focused nature of the advertising delivered by the invention, the targeted advertising developed for delivery by the control system of the invention may include novel elements such as coupons or highly targeted descriptions. Thus, targeted advertising developed for distribution via the present invention may include specific information, couched in specific language, that is intended to be especially appealing to the target audience.

The invention further allows the creation of highly targeted content other than advertisements that can be delivered only to a very specific audience. Thus, movies, shows, religious programs, video magazines, infomercials, etc., may be developed to reach a very specific audience without the restrictions typically imposed on the content developers when the program will reach, or at least be accessible to, a very wide audience. This embodiment will require that such specific content be supplied via dedicated channels that cannot be tuned to directly by a conventional TV tuner, and thus may only be accessed through the control system 2. Such highly targeted content may be provided by alternative content suppliers 25 or even be developed for alternative distribution by conventional programming suppliers 23. Thus, use of the present invention may create a new distribution medium that will allow the content providers to not only reach a very specific audience but also to remotely, automatically <u>exclude</u> certain segments of the audience from accessing this material. Such alternative content could be broadcast exclusively on a viewer's personal channel, as described previously.

The popularity and acceptance of the system of the present invention will depend largely upon the cost to the end users, i.e. the viewers. As such, in one preferred financial arrangement, the user pays a set price for the control system, i.e. the hardware, connects the control system to his TV and incoming cable or satellite dish line, and enjoys the personalized services provided by the control system at no further cost. The system administrator will provide tagged advertisements for broadcast by the broadcast network and charge a fee to the advertisement client. The actual advertisements may be provided by an advertising content supplier or the advertising client itself (e.g. a truck manufacturer), to which the system administrator tags the meta data. The fee may be based upon the total number of control systems installed and/or the target audience that the advertising client wishes to reach. Thus, if a client wishes to air advertisements that are tagged to reach a relatively wide audience of viewers who have purchased and presumably installed the control system of the invention, the fee charged will be proportionally higher than the fee charged for a more narrowly focused advertisement.

Preference Determination System

The following portion of the disclosure discusses one preferred embodiment of a system according to the present invention, referred to as the MbTV system, and provides practical working details regarding the hardware and software implementation of such a system.

Technology Overview

With reference to Fig. 44, MbTV is a set of software libraries that can be integrated with a resident host application, known as the Controlling Application (CApp) on a Set-Top Box (STB). The resident host application manages the

overall control in the STB and interfaces with the MbTV libraries to invoke MbTV functionality. The core services provided by MbTV include automatic viewer preference determination and automatic content-based storage management. Depending on application requirements, MbTV customer libraries can be extended to include such capabilities as automatic recognition of multiple viewers on STBs, targeted advertisements, ad management, content aggregation and presentation, statistical audience measurement and targeted product catalogs. The exact configurations of services included are determined by the customer's implementation requirements.

Data or information that any MbTV services generate can remain at the STB, which does not require remote storage or a back channel mechanism to be functional. Privacy is inherently built into the MbTV architecture.

Some of the services MbTV technologies provide require operational server-side MbTV components. MbTV libraries also assume the availability of some basic services in the STBs. These services are typically available in some form in all STB configurations and include access to Electronic Program Guide (EPG) data mechanisms to control the TV tuner, a DVCR library, and User Interface (UI) management by the Controlling Application.

Technology Applications

Customers can use MbTV technology to build a variety of applications for a STB environment, depending upon consumers' requirements. For instance, a customer could design applications that personalize EPGs, personalize video recorders, and provide video on demand (VOD) systems.

System Architecture

The main control of the MbTV enabled system resides in a
Controlling Application (CApp), which interfaces with various
modules (including the MbTV modules) of the system to manage
the aggregate functionality. The Controlling Application
manages the control flow and the User Interface (UI) for the
system, and calls the appropriate modules to execute user
requests.

The two main components of the MbTV system, controlled
by the CApp, are the Preference Determination Module, or PDM,
and the Storage and DVCR Manager, or SDM. The Controlling
Application notifies the PDM, also sometimes called the
Preference Engine, of a viewer's TV viewing behaviors and
choices. It invokes the various services the Preference
Engine provides, such as generating ratings and personalizing
theme searches. It assumes the availability of an external
EPG library for its internal processing.

All viewer requests that require access to local
storage, such as list creation, DVCR instruction, and filter
management are routed through the SDM. The Storage Manager
passes user requests to underlying modules for actual
execution. All other functions of the system, such as a
tuner control, conditional access, and UI management, are
handled by the Controlling Application directly.

The actual implementation of this architecture may vary,
depending on the customer's system configuration and
application requirements. Figure 44 is a graphical
representation of the architecture of a system integrated
with MbTV software modules.

System Configurations

The system of the present invention as embodied by the
MbTV system described herein provides a scalable technology
that customers can adapt to the resources are available in a

specific configuration. The present specification includes examples of methods to tailor the MbTV technology to suit varying configurations. The services available to these various configurations are also discussed.

Systems Without Local Storage

MbTV technology can easily be adapted to systems with only local storage. Customers can tune MbTV to scale down its persistent memory requirements to fit low-end systems with small amounts of persistent storage (between 4Kb and 16Kb). Such configurations do not include the Storage Manager (SDM) or program recording services. While basic program rating functionality is unaffected in these configurations, some of the more sophisticated personalization services, such as targeted ads, would be suitably scaled down to meet memory requirements.

Personal Video Recorder Systems

Systems with DVR capabilities are the most typical configurations supporting MbTV functionality. On the customer side the system is integrated with the Preference Determination Module and the Storage Manager. All recording requests are forwarded to the DVR library (or DVCR) through the Storage Manager. The Storage Manager controls the storage, retrieval and deletion of all content on the local storage.

Video on Demand and ADSL-Based Server-Switch System

The head end, where the Preference Engine and the Storage Manager reside, controls these configurations, transporting viewer requests through a back channel to the head-end for processing. The system stores all recorded content at the head-end and presents it at the viewer's TV set upon request. Such systems support all MbTV functions with no loss in functionality.

<u>Design Aspects</u>

The MbTV technology disclosed herein is designed to function according to customer requirements, represented by consumer electronics environments. Ease of use and reliability were given high priority in designing MbTV software modules, and were thus developed to be independent of platforms and operating systems by employing modular architecture and well-documented APIs for all external interfaces.

Main Features

A list of the main features of the Preference Determination Module (PDM) and Storage and DVCR Manager (SDM) follows.

<u>Preference Determination Module</u>

- Generates a personalized rating for programs

- Generates a list of top MbTV rated programs for any requested time

- Learns viewer's preferences automatically by monitoring TV watching behavior

- Generates meaningful MbTV ratings as soon as the viewer STB activates the PDM

- Learns up to 80% of viewer's preferences within a predetermined period of time, preferably three weeks of average viewing (assuming 7 hours/day of TV viewing)

- Allows detailed level of customization for power viewers, such as deactivating viewing and modifying viewer profiles

- Allows a personalized theme search to generate programs matching specified criteria

- Customizes learning activities by deactivating learning according to specified criteria

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- Modifies MbTV ratings on a per-program basis
- Provides a private interface to SDM to optimize storage management
- Allows individual customization in multi-viewer households
- Automatically optimizes the list of Top MbTV rated programs for the current set of viewers at the time of the request
- Detects whether the TV is in use.

For a more detailed list of PDM features see detailed discussion of the PDM elsewhere in the disclosure.

Storage and DVCR Manager

- Automatically creates a list of desirable programs to be recorded
- Automatically instructs the DVCR to record and delete appropriate programs
- Creates a schedule for recording and deleting programs that maximizes the value of available storage space
- Specifies explicit programs to be recorded
- Specifies customized filters to capture specific types of program
- Manages storage space allocation by using storage budgets
- Explicitly locks recorded programs to prevent automatic deletion
- Implicitly locks programs to prevent automatic deletion if program is likely to be watched again
- Controls aging of implicit locks
- Automatically determines programs to delete

- Resolves conflicts among programs scheduled for recording
- Creates virtual channels containing recorded programs, for convenient presentation
- Manages playback of virtual channels
- Provides EPG information for virtual channels
- Provides a simple, unified interface by which to access DVCR functionality
- Displays the expected list of programs to be recorded, before actually recording them
- Allows viewers to modify the list of programs to be automatically recorded.

For a more detailed list of SDM features see detailed discussion of the SDM elsewhere in the disclosure.

Architecture

PDM

The MbTV PDM is a machine learning system for a STB environment that learns about a user preference in TV programs by monitoring viewing activity. The knowledge gained by the learning process, which may also be referred to as a user profile, is then used to recommend programs that match the learned TV viewing preference. The learning process employs a wide variety of techniques ranging from statistics, Bayesian probability, to fuzzy logic and concepts of AI. Depending on the implementation requirements the PDM can be implemented as an independent library that could be used to simply rank TV programs. Alternatively when the automatic recording of desirable programs and enabling DVCR functionality for live broadcast channels is included in the implementation requirements, the PDM module could work in conjunction with a Storage and DVCR Manager (SDM) to facilitate automatic recording of TV programs based on the

resident user profile. The PDM can be implemented in two ways:

- As an independent library that ranks TV programs

- As a facilitator of automatic program recording. The decision to record is based on the resident user profile. The PDM also enables DVCR functionality for live broadcast channels. This implementation requires that the PDM module work in conjunction with the Storage and DVCR Manager (SDM), discussed in Section 2.6.

Customer applications can use the data structures and functions in this section to target and manage advertisements, personalize Electronic Program Guides (EPGs) and VCRs, and perform other tasks suitable to your business requirements.

PDM Basic Operations

The PDM operates as a library, providing functions that compute preference determination. It monitors the click stream, the sequence of IR commands issued by the user, and uses this input with EPG information to generate a preference profile. The PDM provides a callback function to the CApp that specifies the requests the user generates during a TV viewing session. The PDM then processes these requests.

The PDM maintains an internal subset of EPG information for all the time periods spanning active viewing sessions, and generates viewer program records from the channel change information provided by the PDM callback function. This data is then used to generate a Preference Database, which creates and updates the user profile.

The PDM interface includes a number of functions.

- Callback functions. These are mandatory functions, and must be invoked by the CApp for the PDM to function. The CApp invokes these functions in

response to specific user events, with as little delay as possible.

- Service functions. These functions provide the PDM services, and their invocation by the CApp is optional unless otherwise specified.

- Housekeeping functions. These are mandatory functions that perform various housekeeping tasks for the PDM. They must be invoked by the CApp, but invoking them is not as time-critical as the callback functions.

Proper functioning of the PDM also assumes certain support functions from the CApp.

- EPG library functions. These are EPG specific functions that control EPG-related data. The PDM may invoke them in the context of a low-priority thread or from one of the PDM functions. Unless otherwise specified, there are no restrictions under which these functions may be invoked.

- OS support functions. These are general-purpose functions, usually provided by the operating system that hosts the CApp.

In addition to the features detailed above, the feature set of the PDM may also include:

- Automatic learning of viewer preferences from user requests generated in an active viewing session

- Generate personalized rating (MbTV rating) for programs

- Generate a list MbTV rating programs for any requested time in order of preference and optimized for the viewers currently active

- Ability to manually train the MbTV PDM

- Override MbTV selections in choice of programs
- Disable automatic learning feature based on certain criteria
- Provide personalized theme search to generate best programs by genre
- Automatic recognition of the current set of viewers
- Manual creation of profiles for multiple viewers in the household
- Allow profile configuration to activate/deactivate a profile and freeze a profile
- Allow explicit login and logout
- Automatic logout for explicit logins based on current TV viewing behavior.

A graphical representation of the STB architecture that includes the PDM is given in Figure 44. The main control of the STB resides in a Controlling Application (CApp) which interfaces with various modules (including the PDM) of a STB to manage the aggregate functionality of a STB. The CApp manages the UI for the STB and calls the appropriate modules to execute user requests. All user requests typically associated with TV Viewing (such as channel change operations) are passed to the PDM. Specific requests to rate programs and control automatic learning are also passed to the PDM.

The PDM also provides the basic functionality of rating programs that are viewed on a MbTV enabled Set Top Box (STB). These rating could be used to generate the list of favorite show for that STB.

The other functionality provided by the PDM is to map the viewing patterns exhibited in the STB to a pre-determined number of clusters.

A cluster is also referred to as a profile. The number of clusters is either specified by the CApp or set to some default value by the PDM.

The PDM is comprised of several modules which interact with each other to provide the above aggregate functionality. These modules execute in 2 distinct contexts or in 2 separate threads of execution, the foreground context (also referred to as executing as a foreground task) and the background context (also referred to as executing as a background task).

Foreground Tasks

The foreground tasks are initiated by the Controlling Application (CApp) in response to actual requests made by the viewer. Of all the request made by a viewer, some of the request are communicated to the PDM only as event notifications, while some of the requests are actually passed to the PDM for further processing.

Event Notifications

One of the most important user requests which is passed by the CApp to the PDM as an event is the channel change event. Each channel change request is monitored by the Viewing Record Manager (VRM) module of the PDM. The VRM uses consecutive channel change operations events to determine the length of the viewing time for a channel. The length of viewing time so determined is stored in a viewer record along with the time of the viewing event and the channel id. Information on which profiles are active at the time of creating the record is also stored in the viewing record. The VRM invokes a PIM function which returns the probability value of the profile being active for all the profiles.

Viewing records whose viewing duration are below a certain threshold are ignored and not processed. The viewing

records created by the VRM in the foreground context are then stored for further processing in the background context.

In addition to generating viewer records for future processing, the VRM also forwards the event notifications from the CApp to the PIM.

The PIM uses these notification events to generate its own records which would be processed in the background context to generate clustering information and determining the current profile mix. For details on the records created by the PIM in the foreground context please refer to the PIMEventRec structure defined in the document titled "Interface Specification for Profile Identification Module".

PDM Request Processing

The requests which are actually processed by the PDM are requests to generate top 10 list of preferred programs, adjustment of MbTV rating of programs, controlling PDM learning behavior & profile operations (such as creating & deleting profiles, modifying profile operation, logging in/out profiles). References to "top 10 list" are meant to denote MbTV picks returned by the functions MbTVGetBestPrograms and MbTVGetCriteriaBasedBestPrograms, as described below.

Background Tasks

The primary responsibility of the background task is to process the viewing records generated by the VRM in the foreground context. The basic inputs for further processing are the viewer records, PIMEventRec records and the EPG data for the programs available during the viewing session for all the viewing record.

The Background Task interacts with all the PDM Modules and co-ordinates and synchronizes all the activity executed in the background context. If there are no background tasks

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to be done or all background tasks are currently completed, the background task goes to sleep. This task is either wakes itself up to complete scheduled tasks or is woken up by the VSM module when it generates a power on event. The tasks handled by the background task are:

- copying of the EPG data for periods when the Viewing Device is active. This handled by the Internal EPG Manager (EM) and is described in the document "IEM_Pat.doc".

- processing the viewer records to determine which programs were watched. This handled by the VRM in background context. When the viewer record are first generated in the foreground context, the duration might actually include more than a single program.

  Such records are further split so that each viewer record refers to a single program. For example if a viewer watches channel NBC without changing channels from 8:00pm to 9:00pm a single viewer record is generated in the foreground context. However during this period the programs available could have been "Friends" (from 8:00-8:30pm) followed by "Fraiser" (from 8:30-9:00pm).

  During the background processing of VRM records such records whose duration straddle multiple programs are split so that each record refers to a single program. In the above example the above record is replaced by 2 new records (NBC at 8:00pm for 30 minutes and NBC at 8:30pm for 30 minutes).

  In addition to sub-dividing viewer records, the VRM also determines which programs have been watched. Each program that is watched by the viewer

beyond a certain threshold is communicated to the
Viewing History Module (VHM). Input to the VHM for
each program viewed is:
-       the channel id associated the channel on which
        the program was watched
-       time at which this program was available.
The VHM uses the above information to query the EM
to get the title, subtitle and episode title of the
program watched. The title, subtitle & episode
title strings returned by the EM are used to
generate a unique 4 byte id. This is then stored by
the VHM to keep a track of the programs watched on
the STB.
-   updating the Category Database (CDB) using the
    processed viewer records and the internal EPG data.
    This task is handled by the Category Database
    Manager (CDB). The CDB takes as input the viewer
    records and the EM EPG data and generates liking
    records which are then inserted or updated in the
    CDB.
-   updating the profile to refine the cluster
    information and compute the current profile mix.
    The background task schedules the function to
    compute the profile mix often enough so as to keep
    the generated profile mix current.
-   scheduling backups to save all the generated
    information onto some persistent memory device.
    This is handled by the I/O manager on a periodic
    basis (once a day) to save all the PDM generated
    data.

In addition to the daily scheduled backup, the I/O
manager also handles unscheduled backups if requested by some

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other PDM module. This data backup is used as an error recovery mechanism in the event of a power failure. When booting up the STB, it is the I/O manager's responsibility to restore the previously saved MbTV generated data.

The data which is backed up (and restored when booting up) includes the CDB, the VHM data and the String Table. If there are any unprocessed viewer records these are backed up (& restored) as well along with the EM records.

Preference Determination Engine

The preferred Preference Determination algorithm uses the principles of a Bayesian classifier to rate programs. The rating given to a program is the probability that the program would be watched by the user. This rating is computed independent of other programs in the lineup, so this is not the probability of the user picking the program from the lineup. The rating is only an indication of how appealing a particular program is to a user.

The probability that a user may watch the program is computed as the probability of the user watching a program given all relevant information available about the situation, $P(w/info)$. For example, in a channel lineup with 50 channels, all channels showing different programs with no information available about the channel line up or the program in those channels, the probability that a user may choose any of these programs is 1/50, i.e $P(w/info) = 1/50$, where info is NULL. If we know the probability of the user picking a program from TNT is 1/5, then $P(w/info) = P(w/channel = TNT) = 1/5$.

If we know all parameters which are relevant and can compute $P(w/all\ relevant\ parameters)$, we may obtain the most accurate computation of $P(w/info)$. But we cannot monitor all parameters which influence the viewer's choice of programs. This is due to two reasons: a) some of the parameters may be

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unknown or cannot be measured, and b) the memory and processing power needed to store all relevant parameters may be too high.

We approximate P(w/info) to P(w/monitored parameters) where the monitored parameters are the most relevant N parameters which we can afford to monitor within our limited resources.

There are numerous ways to compute P(w/monitored parameters). One method is to approximate P(w/monitored parameters) as a function of monitored parameters and compute the coefficients of this function. Any standard regression technique can be used to compute the coefficients of this function. The problem with this approach is that we need to maintain a rather large matrix of information regarding the effects that each parameter, or any arbitrary combination of parameters, has on watching of programs. We therefore preferably employ a different technique to approximate P(w/monitored parameters).

We directly monitor P(w/set of parameters) for different sets of parameters. We qualify the sets of parameters observed by assessing the relevance of the set and also the information content of P(w/set of parameter).

Since we monitor only P(w/set of parameters) for different sets of parameters, we will have to compute P(w/monitored parameters) using the values of P(w/set of parameters) which are monitoring. We use the following principle to compute P(w/monitored parameters):

P(w/a,b) = P(w/a) * P(w/b)/P(w) if a and b are non correlated.

If a and b are correlated and if P(w/b) is greater than P(w), we approximate

P(w/a,b) = P(w/a) if P(w/a) > P(w/b).

This is a good approximation as the most likely values of P(w/a,b) would be between P(a/b) and P(w/a) * P(w/b)/P(w). This is a conservative estimate for P(w/a,b) and thus may be less than the actual value of P(w/a,b).

Since the combination of monitored variables which we are interested in may occur only very rarely, the observed value of P(w/set of parameters) may not be very reliable. In this case we have to assign a weight to this monitored variable which is proportional to the confidence we have for the value of P(w/set of parameters).

If the parameters we are monitoring are a, b, c, d and e, and if we need to compute P(w/a,b,c,d,e) we use the following method to approximate P(w/a,b,c,d,e):

1. Check if P(w/a,b,c,d,e) is monitored. If it is, find out the confidence we have for the monitored value. If the confidence is more that a predefined threshold, use this value as the P(w/a,b,c,d,e).

2. If the confidence is not below the threshold, use the confidence value to weight P(w/a,b,c,d,e).

3. Deduce different ways to compute P(w/a,b,c,d,e) from the monitored combinations of parameters like P(w/a), P(w/c,d,e), P(w/a,b,c) etc. This is done by finding P(w/set of parameters) with the most number of parameters of interest (e.g. choose P(w/a,b,c,d) from the list of possible choices of P(w/a), P(w/a,b), P(w/a,b,c) and P(w/a,b,c,d) and finding the complementary P(w/X) which contains the rest of the parameters (e.g. complementary value for P(w/a,b,c,d) will be P(w/e) if we are trying to compute P(w/a,b,c,d,e)).

4. If the pair of values chosen to approximate P(w/a,b,c,d,e) are P(w/a,b) and P(c,d,e) then

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choose the bigger of these values as the approximation for $P(w/a,b,c,d,e)$. Weight this with a confidence value which is a function of the number of records we have for $P(w/a,b)$ and $P(c,d,e)$.

5. Combine the computed value of $P(w/a,b,c,d,e)$ and the monitored value of $P(w/a,b,c,d,e)$ using the confidence value to weight each of these values.

PDM Interface Data Structures

The C programming language data structures required by the PDM-CApp interface for the preferred embodiment of the MbTV system disclosed herein are described below.

cBackInfo_t

This C structure is used by the CApp when invoking the PDM callback function for event notification. Event notifications are typically associated with channel change operations and the start or completion of a DVCR operations.

The structure definition of *cBackInfo_t* is given below.

```
typedef struct _cBackInfo_
{
    int    currEventType;
    int    prevEventType;
    time_t    eventTime;
    time_t    eventDuration;
    void*    channelID;
    int    channelType;
    inrt errorNum;
    int    reserved;
} cBackInfo_t, *pcBackInfo_t;
```

The semantics of the various fields in the above structure is the following.

- *currEventType* stores the event type which invoked the callback. Possible values for *currEventType* are

  #define MBTV_POWER_ON   1

  #define MBTV_POWER_OFF   2

  #define MBTV_REWIND   3

  #define MBTV_FAST_FORWARD   4

  #define MBTV_PAUSE   5

  #define MBTV_RESUME   6

  #define MBTV_PLAY   7

  #define MBTV_JUMP_TO_LIVE   8

  #define MBTV_CHANNEL_CHANGE 9

  #define MBTV_ADD_CHANNEL   10

  #define MBTV_DEL_CHANNEL   11

  #define MBTV_STOP   12

  #define MBTV_RECORD   13

  #define MBTV_SKIP_FORWARD   14

  #define MBTV_SKIP_BACKWARD 15

The above events are defined below.

- The *MBTV_POWER_ON* event indicates a transition in the TV Viewing Device from the inactive to the active state.

- The *MBTV_POWER_OFF* event indicates a transition in the TV Viewing Device from the active to the inactive state.

- The *MBTV_REWIND* event indicates the start of the rewind operation. Information on the duration by which a program has been rewound is available later through a separate stop event.

- The *MBTV_FAST_FORWARD* event indicates the start of the fast forward operation. Information on the duration by which a program has been fast forwarded is available later through a separate stop event.

- The *MBTV_STOP* event indicates the termination of the current DVCR request. Information available through this callback is dependent on the DVCR operation that has been terminated. The callback indicates the operation that has been terminated and specifies the relevant duration of the concluded operation.

- The *MBTV_PAUSE* event indicates pausing of playback or recording on the current channel. This event is not used to indicate the stopping of a rewind or fast forward operation.

- The *MBTV_RESUME* event indicates resumption of playback on the current channel that was paused.

- The *MBTV_PLAY* event to indicate start of playback on the current channel. Playback operation that are initiated due to a channel change operation are not indicated through this event.

- The *MBTV_JUMP_TO_LIVE* event indicates invocation of the Jump to live request.

- When *channelType* is set to *CHANNEL_TYPE_VIRTUAL,* the *MBTV_ADD_CHANNEL* & MBTV_DELETE_CHANNEL events indicate addition or deletion of a virtual channel. Each program that is recorded is associated with a Virtual Channel and the recorded program is considered to be available on that Virtual Channel. Creation and deletion of stored programs are synonymous with program recordation and deletion.

  When *channelType* is set to *CHANNEL_TYPE_LIVE, the MBTV_ADD_CHANNEL* and *MBTV_DELETE_CHANNEL* events are used to indicate changes in the live broadcast channel lineup.

  Changes in the subscription of live premium channels are also indicated with the *MBTV_ADD_CHANNEL*

and *MBTV_DELETE_CHANNEL* events. When indicating a
subscription to a live premium channel, the
currEventType field is set to *MBTV_ADD_CHANNEL* and the
channelType field has the *CHANNEL_TYPE_LIVE* and
CHANNEL_TYPE_PREMIUM bits set. To indicate an un-
subscription of a premium channel, the
MBTV_DELETE_CHANNEL event is used with the *channelType*
field set as above.

- The *MBTV_SKIP_FORWARD* & *MBTV_SKIP_BACKWARD* events
  indicate the completion of a skip forward or a skip
  backward operation.

- The *MBTV_CHANNEL_CHANGE* event indicates a channel
  change operation.

- The *MBTV_RECORD* event indicates start of a record
  operation.

- *prevEventType* is valid only if the *currEventType* is set to
  MBTV_STOP or MBTV_PAUSE. The *prevEventType* field stores the
  DVCR operation that has been stopped or paused explicitly
  by a requested stop or pause operation or implicitly by an
  EOF/BOF condition. Legal values of *prevEventType,* when
  currEventType is set to *MBTV_STOP,* are *MBTV_FAST_FORWARD,*
  MBTV_REWIND, MBTV_PLAY and *MBTV_RECORD.* Legal values of
  prevEventType, when *currEventType* is set to *MBTV_PAUSE,* are
  MBTV_PLAY and *MBTV_RECORD.*

- *eventTime* stores the time in GMT format at which event
  occurred.

- *eventDuration* contains context dependent information. When
  prevEventType is set to *MBTV_REWIND* or *MBTV_FAST_FORWARD,*
  eventDuration stores the amount of time (in seconds) by
  which the current program has been rewound or fast
  forwarded. When *prevEventType* is set to *MBTV_PLAY* or
  MBTV_RECORD, eventDuration contains the playback duration

or recording duration. When *currEventType* is set to
MBTV_RESUME eventDuration contains the playback duration or
recording duration depending on the operation that was
resumed. The CApp does not provide information on the
operation which has been resumed and assumes that the
callback target maintains the necessary context
information. When *prevEventType* is set to
MBTV_SKIP_BACKWARD or *MBTV_SKIP_FORWARD*, the duration field
is set to the amount of time that has been skipped backward
or skipped forward respectively.

- *channelID* stores the channel ID of the channel associated
  with the event.

- *channelType* stores the channel type as to whether it refers
  to a live broadcast channel or a Virtual Channel for a pre-
  recorded program. Information in this field is stored in a
  bit-wise manner. For live broadcast channels, an additional
  bit, *CHANNEL_TYPE_PREMIUM,* is used to indicate premium
  channels. Possible values of *channelType* are

  #define CHANNEL_TYPE_LIVE   0x01

  #define CHANNEL_TYPE_VIRTUAL   0x02

  #define CHANNEL_TYPE_PREMIUM 0x80000000

- *reserved* is a reserved field and should accessed or
  modified by the PDM.

pgmInfo_t

This C structure is used by the CApp when invoking the PDM
service functions to get rating of TV programs. The structure
definition of *pgmInfo_t* is given below.

*typedef struct _pgmInfo_*

{

  void   channelID;*

  int   channelType;

  char   pgmTitle;*

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```
short      pgmTitleLen;

time_t     pgmStartTime;

float      pgmRating[MBTV_MAX_NUM_PROFILE];

int  pgmDuration;

int  pgmRank;

uint pgmReserved;

} pgmInfo_t, *ppgmInfo_t;
```

The semantics of the various fields in the above structure are the following.

- *channelID* stores the channel ID associated with the channel in which the program is being played.

- *channelType* stores the channel type as to whether refers to a live broadcast channel or a Virtual Channel for a pre-recorded program. Possible values of *channelType* are as described in the pervious section.

- *pgmTitle* stores a pointer to a string describing the title name. It points to a valid memory location allocated by the owner of the *pgmInfo_t* structure. The number of bytes allocated for the title string is specified in the field *pgmTitleLen*.

- *pgmTitleLen* is used both as an input and output variable. On input it specifies the number of bytes allocated for storing the title string including the string terminator. On output it specifies the actual length of the title string. The title string is truncated if the title string length is more than the number of bytes specified in *pgmTitleLen* on input. *pgmTitleLen* is set to 0 if no program is available during the time specified in *pgmStartTime*.

- *pgmStartTime* stores the start time of the program in GMT format or any time within the program duration. It can also be set to 0 to specify the current time as the start time.

- *pgmRating* stores an array of MbTV generated rating for this program.

- *pgmDuration* stores the duration of the program in minutes.

- *pgmRank* stores the rank of the program in a list of specified list of programs.

- *pgmReserved* is reserved for future use and its contents are ignored by the PDM.

profile_t

This C structure is used by the CApp to set and modify various parameters associated with a profile. The structure definition of *profile_t* is given below.

```
typedef struct _profile_
{
    ulong       id;
    int  probability;
    ulong       status;
    #define    PROFILE_DISABLED    0x01
    #define    PROFILE_FROZEN 0x02
    char name[MBTV_MAX_PROFILE_NLEN];
}profile_t, *pprofile_t;
```

The semantics of the various fields in the above structure are the following.

- *id* uniquely identifies this profile.

- *probability* specifies the probability as a percentage value of the profile being currently logged on either explicitly by a viewer or implicitly as deduced by the PDM.

- *status* is a bit-wise field and specifies the current state of the profile. When the *PROFILE_DISABLED* bit is set, all learning activity for this profile is suspended. The programs matching the preferences of such a profile are not considered by the PDM when generating top 10 lists. In configurations that support storage

devices, recording storage space allocated for such a profile is released. When the *PROFILE_FROZEN* bit is set, only learning activity for this profile is suspended. The programs matching the preferences of such a profile are still considered by the PDM when generating top 10 lists and by the SDM during automatic recording.

- *name* associates an alpha-numeric identifier with the profile.

prob_t

This C structure is used by the PDM to specify the set of profiles that are currently engaged in watching TV. This information is passed for each profile supported by the PDM as the probability of a profile being currently engaged in watching TV. The structure definition of *prob_t* is given below.

*typedef struct _prob_*

{

    ulong   profileId;

    int probability;

*} prob_t, * pprob_t;*

The semantics of the various fields in the above structure are the following.

- *profileId* specifies the profile.

- *probability* specifies the probability of the associated profile being currently engaged in watching TV as a percentage value.

dfilter_t

This C structure is used by the CApp to provide learning deactivation information. Learning deactivation is based on channels and/or specific viewing times. The structure definition of *dfilter_t* is given below.

*typedef struct _dfilter_*

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```
{
    ulong      id;
    void*      chnlID;
    int   deactivateStart
    int   deactivateEnd;
}dfilter_t, *pdfilter_t;
```

The semantics of the various fields in the above structure
are the following.

- *id* uniquely identifies this learning deactivation
  filter.

- *chnlID* stores the channel ID associated with the channel
  on which learning is being disabled. If this field is
  set to NULL, no channels are monitored for learning
  purposes during the time specified by the
  deactivateStart & *deactivateEnd*.

- *deactivateStart* stores the start time of the deactivation
  period. Live TV programs available during the deactivation
  period are not monitored for learning purposes. This field
  is specified in 24 hour *hhmm* format.

- *deactivateEnd* stores the end time of the deactivation
  period. This field is specified in 24 hour *hhmm* format. If
  deactivateStart and *deactivateEnd* are set to a negative
  value, the corresponding channel is no longer monitored to
  for learning purposes.

filterType_t

This C structure is used by the CApp to provide filter type
information for all filter types supported by the CApp.
Filter types are used to provide search parameters when
requesting ratings of programs matching a specified search
criteria or for controlling automatic storage configuration
in the SDM. The CApp determines the number of filter types
that are to be supported and it uses the *filterType_t*

structure to pass filter type information to MbTV modules.
Some examples of filter types are PROGRAM TYPE, PROGRAM
CHANNELS, PERFORMERS, PARENTAL RATING etc.

```
typedef struct _filterType_
{
        ulong       filterTypeID;
        int   numEPGParams;
        int   epgParamNums[MBTV_MAX_NUM_SFILTER];
        int   epgDataType;
        #define    MBTV_TYPE_CHAR 1
        #define    MBTV_TYPE_INT16      2
        #define    MBTV_TYPE_INT32      3
        #define    MBTV_TYPE_UINT16     4
        #define    MBTV_TYPE_UINT32     5
        #define    MBTV_TYPE_SUBSTRING 6
        #define    MBTV_TYPE_STRING     7
        char filterTypeName[MBTV_MAX_FTYPE_NLEN];
} filterType_t, *pfilterType_t;
```

The semantics of the various fields in the above structure
are the following.

- the *filterTypeID* uniquely identifies each filter type. This
  field is passed to the SDM when creating SDM filters.

- the *numEPGParams* field specifies the number of EPG
  parameters associated with this filter type.

- the *epgParamNums* array stores the EPG parameters associated
  with this filter type. Most filter types are associated
  with a single EPG parameter, however there are instances of
  a single filter type being mapped to multiple EPG
  parameters provided all the mapped EPG parameters are of
  the same data type. A typical example of a filter type that
  is associated with multiple EPG parameters is PERFORMERS.

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EPG data for movies usually contain names of multiple performers.

- the *epgDataType* field stores the data type of the EPG parameters associated with the filter type. In scenarios where multiple parameters are mapped to a single filter type, all the mapped EPG parameters must be of the same data type. Details on the data types enumerated above are:

  - *MBTV_TYPE_CHAR* to specify a single byte character.
  - *MBTV_TYPE_INT16* to specify a 2 byte integer
  - *MBTV_TYPE_INT32* to specify a 4 byte integer
  - *MBTV_TYPE_UINT16* to specify a 2 byte unsigned integer
  - *MBTV_TYPE_UINT32* to specify a 4 byte unsigned integer
  - *MBTV_TYPE_STRING* to specify a NULL terminated string (to specify whole string matches)
  - *MBTV_TYPE_SUBSTRING* to specify a NULL terminated substring (to specify matches with a part of a string).

- the *filterTypeName* stores the name of the filter type in a NULL terminated string.

srchFilter_t

This C structure is used by the CApp to provide search data when searching for best programs based on a specified criterion. The structure definition of *srchFilter_t* is given below.

```
typedef struct _srchFilter_
{
    ulong  filterTypeID;
    char   searchString[MBTV_MAX_NUM_SFILTER]
                     [MBTV_MAX_SFILTER_PLEN];
```

*}srchFilter_t, *psrchFilter_t;*

The semantics of the various fields in the above structure are the following.

- the *filterTypeID* identifies the filter type associated with this search criteria. The *filterTypeID* is used to get information on which parameters of the EPG yield information corresponding to this filter.

  - the *searchString* array field stores the search string associated with the search filter. The CApp converts non-string data into a NULL terminated string before being passed it in the *srchFilter_t* structure. If the filter type corresponds to **Program Channel,** possible values for the search filter string could be CNN, TNT etc. Alternatively if the filter type corresponds to **Program Type,** possible values for filter string could be sitcoms, talk show etc. The number of strings specified in the *searchString* array could be less than or equal to the number of EPG parameters specified in the associated filter type. For filter types which are mapped to multiple EPG parameters, each string passed in *searchString* array is searched in all the EPG parameters specified in the associated filter type.

PDM Interface Functions

The interface functions provided by the PDM are described in the following sections.

PDM Callback Functions

These functions are mandatory functions which must be invoked by the CApp for the PDM to function correctly. The CApp invokes these functions to indicate user requests to the PDM.

MbTVCallback

void

MbTVCallback(struct cBackInfo_t* pcBackInfo)

This function is called during a channel change event, when a DVCR function (such as pause, resume, play, rewind or fast forward) is invoked, during a channel lineup change event, during a TV Power on event or a TV Power off event. (TV Power on & TV Power off events do not alter the power status of the Set Tob Box but of the TV viewing device only). *pcBackInfo* points to a structure of type *cBackInfo_t* allocated by the CApp. The CApp is free to use this structure on returning from .

PDM Service Functions

These functions expose the services provided by the PDM. These functions are invoked to rank programs based on the preferences of a user profile.

MbTVGetProgramRating

int

MbTVGetProgramRating(struct pgmInfo_t *pgmInfo)

This function computes the MbTV rating of the TV program specified in the *pgmInfo_t* structure pointed to by *pgmInfo*. A composite rating is computed for the profile/profiles currently logged on, either logged explicitly by the viewer or implicitly as deduced by the PDM. This composite rating is returned in the first element of the *pgmRating* array. Alternatively *MbTVGetProgramRating* could also be used for computing the ratings for all the currently active profiles. A profile is considered to be active if it is not in a disabled state. The rating for each of the individual profiles is returned in the *pgmRating* array. A negative number is returned for an inactive (ie disabled) or deleted profile.

The CApp allocates the *pgmInfo_t* structure and sets the *channelID* and *pgmStartTime* fields in the *pgmInfo_t* structure.

The caller ensures that the *pgmTitle* points to a valid memory location in the callers address space and contains the program title in a NULL terminated string. Setting of the *pgmDuration* and *pgmTitle* fields by the CApp is optional.

If the *pgmStartTime* is set to 0, this functions returns that rating of the program currently available in the *channelID* channel. If the *pgmStartTime* does not match the start time of any program, *MbTVGetProgramRating* returns the rating for the appropriate program available at *pgmStartTime* time on that channel and updates the *pgmStartTime* with the corresponding start time. A composite rating is returned when the first element of the *pgmRating* array is set to 0 and profile specific rating is returned otherwise.

MbTVGetProgramRating returns a 0 value in case of success and a non zero error value is returned in case of failure. In case of success, the PDM initializes the *pgmRating* array either for a composite rating or for specifically for each profile. The rating for the Nth profile is returned in the N-1th location in the *pgmRating* array.

MbTVSortPrograms

int

*MbTVSortPrograms(int progCount, pgmInfo_t *ppgmInfo[])*

MbTVSortPrograms sorts the input list of TV programs in descending order of program preference with the most preferred program being given a rank of 1. This function automatically determines the profiles that are currently logged on and performs the sort operation based on the composite preferences of the profiles currently logged on either explicitly or implicitly as deduced by the PDM. The same set of programs might thus be sorted in a different order depending on which profiles are currently actively engaged in watching TV. Alternatively *MbTVSortPrograms* could

also be used to sort the input list of TV programs based on the preferences of a specific profile.

progCount contains the number of programs to sort. *ppgmInfo* is an array of pointers for the TV programs which need to be sorted. The array of pointers and the corresponding *pgmInfo_t* structures are allocated by the CApp. The CApp sets the *channelID,* and *pgmStartTime* fields of all the programs referred to by the *ppgmInfo* array. The caller ensures that the *pgmTitile* points to a valid memory location in the callers address space and contains the program title in a NULL terminated string. Setting of the *pgmDuration* and *pgmTitle* field by the CApp is optional. Sorting based on the composite preference is done if all the elements of the *pgmRating* array are set to 0. Sorting is done based on a specific profile if the corresponding *pgmRating* array element is set to 1 and all other elements are set to 0. If the specified profile is an invalid profile or a deleted profile, an error is returned and the *pgmRating* array element is set to a negative number. An error is also retuned if the *pgmRating* array is not initialized as specified above.

This function would be called by the CApp in response to a user's request to rank programs. It is assumed the CApp can provide Program parameters for the programs specified in *ppgmInfo*.

On success a zero value is returned and a non zero error value otherwise. In case of success, the PDM initializes the *pgmRank* field of all the programs referred to by the *ppgmInfo* array. The contents of the *pgmRating* array are undefined when a composite sort is performed.

MbTVGetBestPrograms

int

MbTVGetBestPrograms(int progCount, pgmInfo_t ppgmInfo[],*

time_t startTime, time_t endTime)

MbTVGetBestPrograms returns a list in descending order
of preference of the top **n** TV programs starting between
startTime and *endTime* where **n** is specified in *progCount*. This
function automatically determines the profiles that are
currently logged on and generates the best program list based
on the composite preferences of the profiles currently logged
on either explicitly or implicitly as deduced by the PDM. The
same specified time period might generate a different set of
programs depending on which profiles are currently actively
engaged in watching TV. Alternatively *MbTVGetBestPrograms*
could also be used to generates the best program list based
on the preferences of a specific profile.

The array of pointers and the corresponding *ppgmInfo_t*
structures are allocated by the CApp. *startTime* and *endTime*
are specified in GMT format. The caller ensures that each
pgmTitle pointer is set to a valid memory location in the
callers address space if the *pgmTitleLen* field is set to an
integer value greater than 0. Generating the list of best
programs based on the composite preference is done if all the
elements of the *pgmRating* array are set to 0. Generating the
list of best programs based on a specific profile is done if
the corresponding *pgmRating* array element is set to 1 and all
other elements are set to 0. If the specified profile is an
invalid profile or a deleted profile, an error is returned
and the *pgmRating* array element is set to a negative number.
An error is also retuned if the *pgmRating* array is not
initialized as specified above.

This function would be called by the CApp in response to
a user's request to get the most preferred programs.

On success a zero value is returned and a non zero error
value otherwise. In case of success, the PDM sets the

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channelID, *pgmStartTime*, *pgmDuration* and *pgmRank* fields of all the programs referred to by the *ppgmInfo* array. The *pgmTitle* field is set only if the *pgmTitleLen* field is set to an integer value greater than zero. The array is sorted in descending order of *pgmRank* with the most preferred program having a rank of 1.

MbTVGetCriteriaBasedBestPrograms

int

MbTVGetCriteriaBasedBestPrograms (int progCount,

    pgmInfo_t* ppgmInfo[],

    time_t startTime, time_t endTime,

    int numFilters,

    srchFilter_t *psrchFilter)

    MbTVGetCriteriaBasedBestPrograms provides the same functionality as the *MbTVGetBestPrograms* function with the difference being that only programs matching a specified criterion are considered.

The array of pointers and the corresponding *ppgmInfo_t* structures are allocated by the CApp. *startTime* and *endTime* are specified in GMT format. The caller ensures that each *pgmTitle* pointer is set to a valid memory location in the callers address space if the *pgmTitleLen* field is set to an integer value greater than 0. The search criteria are passed in an array of *srchFilter_t* structures pointed to by the parameter *psrchFilter*. The size of this array is specified in the parameter *numFilters*. Only those programs whose EPG data matches all the specified search criterion are considered when generating the list of preferred programs.

On success a zero value is returned and a non zero error value otherwise. In case of success, the PDM sets the *channelID*, *pgmStartTime*, *pgmDuration* and *pgmRank* fields of all the programs referred to by the *ppgmInfo* array. The

pgmTitle field is set only if the *pgmTitleLen* field is set to an integer value greater than zero. The array is sorted in descending order of *pgmRank* with the most preferred program having a rank of 1.

MbTVGetNumProfiles

int

MbTVGetNumProfiles(int *cntProfile)

The CApp calls this function to get the number of profiles currently supported. The input parameter *cntProfile* is used to return the number of profiles currently available.

On success it returns a zero value and non-zero error value otherwise. The input parameter *cntProfile* is set when returning success.

MbTVGetProfileID

int

MbTVGetProfileID(int profileNum, ulong *profileID)

This functions is called to get the profile ID. Input to this function is an integer parameter, *profileNum*, set between 0 and **N-1** where **N** is the return value of *MbTVGetNumProfiles*. The associated profile ID is returned in the parameter *profileID*.

On success it returns a zero value and non-zero error value otherwise.

MbTVGetProfileNumber

int

MbTVGetProfileNumber(ulong profileID, int *profileNum)

This function provides the reverse functionality of the *MbTVGetProfileID* functions and gives the mapping from the profile id specified by *profileID* to the profile number. The input parameter *profileNum* is set to a value between 0 to **N-1** where **N** is the return value of *MbTVGetNumProfiles*.

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On success it returns a zero value and non-zero error value otherwise. The input parameter *profileNum* is set when returning success.

MbTVAddProfile

int

*MbTVAddProfile(ulong *profileID)*

This functions is used to create a new profile with a set of predefined defaults. The maximum number of profiles that can be created is implementation specific and is set to some predefined upper limit. Calls to *MbTVAddProfile* fails when the number of filters created equals this predefined upper limit.

On success it returns a zero value and non-zero error value otherwise. On success the input parameter *profileID* is set to the profile ID of the newly created profile.

MbTVDeleteProfile

int

MbTVDelProfile(ulong profileID)

This function is used to delete the profile specified by the input parameter *profileID*.

On success it returns a zero value and non-zero error value otherwise.

MbTVGetProfileParams

int

*MbTVGetProfileParams(ulong profileID, profile_t *pprofile)*

This function copies the *profile_t* structure associated with the profile *profileID* into the profile_t structure pointed to by *pprofile*. *pprofile* points to an area allocated in the caller address space.

On success it returns a zero value and non-zero error value otherwise.

MbTVSetProfileParams

int

*MbTVSetProfileParams(ulong profileID, profile_t *pprofile)*

    This function sets the profile parameters associated with the profile *profileID* as per the profile data in the profile_t structure pointed to by *pprofile*. *pprofile* points to an area allocated in the caller address space.

    On success it returns a zero value and non-zero error value otherwise.

MbTVGetCurrentProfile

int

*MbTVGetCurrentProfile(int numProfiles, prob_t *profileProbability)*

    This function returns information on which of the specified profiles are currently engaged in watching TV. The profiles of interest are passed in the *profileID* field of the prob_t structures pointed to by *profileProbability*. If the *profileID* field is set to NULL, information is passed for first *numProfiles* profiles supported by the PDM and the *profileID* field is set accordingly. The *probability* field is set to the probability of that profile being currently engaged in watching TV. A probability value of 100 indicates an explicitly logged in profile. A probability value above a predetermined threshold may be considered as a completely recognized profile.

    On success it returns a zero value and non-zero error value otherwise.

MbTVLoginProfile

int

MbTVLoginProfile(ulong profileID)

    This function is called to explicitly login the profile specified by *profileID*.

An explicit login is used as a mechanism to explicitly inform the PDM about the presence of a profile in a TV viewing session. Explicit logins also influences the program lists generated by MbTV functions such as *MbTVSortPrograms, MbTVGetBestPrograms* and *MbTVGetCriteriaBasedBestPrograms.*

On success it returns a zero value and non-zero error value otherwise.

MbTVLogoutProfile

int

MbTVLogoutProfile(ulong profileID)

This function is called to explicitly logout the profile specified by *profileID*. A profile might also be logged out automatically as the login session ages and the viewing behavior of a previously logged in profile diverges.

On success it returns a zero value and non-zero error value otherwise.

MbTVGetNumDFilters

int

*MbTVGetNumDFilters(int *cntDFilters)*

The CApp calls this function to get the number of learning deactivation filters currently supported. The input parameter *cntDFilters* is used to return the number of deactivation filters currently available.

On success it returns a zero value and non-zero error value otherwise. The input parameter *cntDFilters* is set when returning success.

MbTVGetDFilterID

int

*MbTVGetDFilterID(int dfilterNum, ulong *dfilterID)*

This function is called to get the learning deactivation filter ID. Input to this function is an integer parameter, *dfilterNum*, set between 0 and **N-1** where **N** is the return value

of *MbTVGetNumDFilter*. The associated deactivation filter ID is returned in the parameter *dfilterID*.

On success it returns a zero value and non-zero error value otherwise.

MbTVCreateDFilter

int

*MbTVCreateDFilter (ulong *dfilterID)*

This function is used to create a new learning deactivation filter. The maximum number of deactivation filters that can be created is implementation specific and is set to some predefined upper limit. Calls to *MbTVCreateDFilter* fails when the number of filters created equals this predefined upper limit.

On success it returns a zero value and non-zero error value otherwise. On success the input parameter *dfilterID* is set to the filter ID of the newly created deactivation filter.

MbTVDeleteDFilter

int

MbTVDeleteDFilter (ulong dfilterID)

This function is used to delete the learning deactivation filter specified by the input parameter *dfilterID*.

On success it returns a zero value and non-zero error value otherwise.

MbTVGetDFilter

int

*MbTVGetDFilter (ulong dfilterID, dfilter_t *pdFilter)*

This function returns information on the learning deactivation filter specified by *dfilterID*. The dfilter_t structure, allocated by the caller, is filled with the filter information.

On success it returns a zero value and non-zero error value otherwise.

MbTVSetDFilter

int

MbTVSetDFilter (ulong dfilterID, dfilter_t *pdFilter)

This function sets the learning deactivation filter parameters associated with *dfilterID* as per the filter data in the dfilter_t structure pointed to by *pdFilter*. *pdFilter* points to an area allocated in the caller address space.

On success it returns a zero value and non-zero error value otherwise.

MbTVAdjustRating

int

MbTVAdjustRating(pgmInfo_t* ppgmInfo, float newRating)

MbTVAdjustRating accepts user input in terms of modification of the rating of a program. *ppgmInfo* structure specifies the program for which the rating has to be modified. PDM will modify the rating of this program to *newRating*. This will affect the profile logged on, either explicitly by a viewer or implicitly as deduced by the PDM

This function would be called by the CApp in response to a user's modification of a rating of a program. It is assumed that the CApp can provide Program parameters for the programs specified in *ppgmInfo*.

Invocation of this function is mandatory if the program rating have been modified by the user.

On success a zero value is returned and a non-zero error value otherwise.

PDM Housekeeping Functions

These functions perform various housekeeping tasks of the PDM. These are mandatory functions which must be invoked by the CApp as indicated below.

MbTVInit

int

MbTVInit()

MbTVInit initializes the PDM and starts the PDM. This routine may perform memory allocations and spawn threads to perform various house keeping tasks of the PDM. This routine must be the first PDM function invoked by the CApp.

On success a zero value is returned and a non zero error value otherwise. The PDM application will not launched in case of error.

This function would be called once by the CApp to launch the PDM. It is assumed that this function is allowed to allocate memory and spawn threads for back ground tasks.

PDM Support Functions

The support functions required by the PDM are described in the following sections.

These EPG support functions are EPG specific functions which generally deal with EPG related data. The PDM may invoke them in the context of a low priority thread or from one of the PDM functions. It is assumed that there are no restrictions under which these functions may be invoked unless other specified. Details on EPG library functions are given below.

EPGGetNumChannels

int

*EPGGetNumChannels(int *cntChannel)*

EPGGetNumChannels returns the number of TV Program Channels in the current lineup. The number of channels are returned by the EPG in the *cntChannel* parameter.

On success a zero value is returned and a non zero error value otherwise. The *cntChannel* parameter is set on success.

EPGGetChannelID

int

EPGGetChannelID(int channelIndex, void* channelID)

      EPGGetChannelID returns a unique 4 byte channel Id in the *channelID* parameter for the channel number specified by *channelIndex*. The value of *channelIndex* ranges from 0 to N-1 where N is the number of channels returned by the *EPGGetNumChannels* call. The *channelID* is set to a valid memory location allocated in the callers address space. The channel ID returned must be a unique and must not be reused without first notifying the PDM through *MBTV_ADD_CHANNEL and MBTV_DEL_CHANNEL events*. Typical situations where a channel ID may be reused would include deletion of a channel from the lineup and reusing the channel ID for a new channel added subsequently to the lineup.

      It is assumed that the channel ID returned by this routine will be used to refer to a channel in all PDM functions and all future calls to CApp support functions.

      On success a zero value is returned and a non zero error value otherwise. On success the *channelID* parameter is set by *EPGGetChannelID*.

EPGGetChannelParams

int

EPGGetChannelParams(void* channelID, int paramNum,
                    char *channelParam)

      EPGGetChannelParams returns information on the Nth parameter of the channel information specific to *channelID*. The value of N is specified in *paramNum*. The information returned by parameter N and the acceptable values for *paramNum* is EPG specific. *EPGGetChannelParams* returns the parameter information as a NULL terminated string and copies the string into the memory location pointed to by *channelParam* and allocated by the caller in its own memory

space. If no channel information is available, an NULL string is copied into *channelParam*. The amount of memory to be allocated should be MBTV_MAX_CHNL_PARAM_SIZE. The EPG used by the CApp and all EPG specific values and parameters are known by the PDM at compile time.

On success a zero value is returned and a non zero error value otherwise. The *channelParam* parameter is set when successful.

EPGGetChannelDataBufferSize

int

EPGGetChannelDataBufferSize(void* channelID, int* size)

EPGGetChannelDataBufferSize returns the buffer size required to copy the entire channel data information for the channel specified by the *channelID* parameter. The actual format of the structure for passing channel information is EPG specific and is transparent to MbTV modules but it would contain all the information that would be returned by multiple invocations of *EPGGetChannelParams* with valid values of *paramNum*.

On success a zero value is returned and the input parameter *size* is set to size of the buffer required. A non zero error value is returned in case of failure.

EPGFillChannelDataBuffer

int

EPGFillChannelDataBuffer(void* channelID, void* chnlData,
    int size)

EPGFillChannelDataBuffer copies the entire channel data information into the specified buffer allocated by the caller. The buffer is accessed through the input void pointer *chnlData* and on successful completion of this call contains all channel parameters specific to the channel in *channelID*. The size of the buffer is specified by the *size* parameter The

actual format of the structure for passing channel information is EPG specific and is transparent to MbTV modules but it would contain all the information that would be returned by multiple invocations of *EPGGetChannelParams* with valid values of *paramNum*.

On success a zero value is returned and a non zero error value otherwise.

The *chnlData* parameter is set when successful. An error is returned if the specified buffer size is less than the memory required for copying the channel data information.

EPGGetChannelParamFromDataBuffer

EPGGetChannelParamFromDataBuffer(void* chnlData,

    int paramNum,

    int *paramType,

    char *paramValue)

EPGGetChannelParamFromDataBuffer returns information on the Nth parameter of the channel data information specific to the channel specified by contents of the input buffer *chnlData*. The value of N is specified in *paramNum*. and the contents of the *chnlData* buffer are initialized by an earlier call to the *EPGFillChannelDataBuffer* function.

The information returned by parameter N and the acceptable values for *paramNum* is EPG specific. *EPGGetChannelParamFromDataBuffer* returns the parameter value as a NULL terminated string and copies the string into the memory location pointed to by *paramValue* and allocated by the caller in its own memory space. The amount of memory to be allocated is EPG specific. The EPG used by the CApp and all EPG specific values and parameters are known by the PDM at compile time. The actual data type of the EPG parameter is specified in the parameter *paramType*. Acceptable value for data type are as enumerated in the *filterType_t* structure.

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On success a zero value is returned and a non zero error value otherwise.

The parameter value is copied into *paramValue* parameter is set when successful.

EPGGetProgramInfo

int

EPGGetProgramInfo(pgmInfo_t* pgmInfo)

EPGGetProgramInfo returns information on the TV program specified by the *channelID* and *pgmStartTime* fields in the *pgmInfo* parameter.

The *EPGGetProgramInfo* sets pgmDuration field and copies the program title as a NULL terminated string into the memory location specified by the *pgmTitle* field if the pgmTitleLen field is set an integer value greater than 0. The amount of memory space allocated for the program title is specified in the *pgmTitleLen* field on input and allocated by the caller in its own memory space. On output the *pgmTitleLen* field is set to the actual length of the program title. The program title is truncated if the memory provided does not accommodate the entire title string. If the *pgmStartTime* is set to a zero value on input, information is returned for the current TV program available on that channel and the *pgmStartTime* field is updated with the corresponding start time. If the *pgmStartTime* does not match the start time of any program, *EPGGetProgramInfo* returns information for the appropriate program available at *pgmStartTime* time on that channel and updates the *pgmStartTime* with the corresponding start time. *The channelType, pgmRating* and *pgmRank* fields are ignored.

If no program is available at the requested time, the *pgmTitleLen* field is set to 0 and the memory location specified by *pgmTitle* contains a NULL string, the *pgmStartTime* is set to the time from when no programs are

available and the *pgmDuration* is set to the number of minutes for which no programs are available.

On success a zero value is returned and a non zero error value otherwise.

EPGGetProgramParams

int

EPGGetProgramParams(ppgmInfo_t pgmInfo, int paramNum,

char *pgmParam)

EPGGetProgramParams returns information on the Nth parameter of the program information specific to the program specified by *pgmInfo*. The value of N is specified in *paramNum*. The information returned by parameter N and the acceptable values for *paramNum* is EPG specific. *EPGGetProgramParams* returns the parameter information as a NULL terminated string and copies the string into the memory location pointed to by *pgmParam* and allocated by the caller in its own memory space. The size of the buffer provided by the caller should be *MBTV_MAX_PGM_PARAM_SIZE*. The EPG used by the CApp and all EPG specific values and parameters are known by the PDM at compile time.

The caller sets the *channelID*, and *pgmStartTime* fields of the *pgmInfo* parameter. Initialization of the *pgmInfo* structure by the *EPGGetProgramParams* function is as described above for the *EPGGetProgramInfo* function. Additionally the *pgmTitleLen* filed is set to 0 and a NULL string is copied into the *pgmParam* parameter if no program is available at the specified time.

On success a zero value is returned and a non zero error value otherwise. The pgmParam parameter is set when successful.

EPGGetProgramDataBufferSize

int

EPGGetProgramDataBufferSize(ppgmInfo_t pgmInfo, int* size)

EPGGetProgramDataBufferSize returns the buffer size required to copy the entire program data information for program specified by the *pgmInfo* parameter. The actual format of the structure for passing program information is EPG specific and is transparent to MbTV modules but it would contain all the information that would be returned by multiple invocations of *EPGGetProgramParams* with valid values of *paramNum*.

The caller sets the *channelID*, and *pgmStartTime* fields of the *pgmInfo* parameter. Initialization of the *pgmInfo* structure is as described above for the *EPGGetProgramInfo* function.

On success a zero value is returned and the input parameter *size* is set to size of the buffer required. A non zero error value is returned in case of failure.

EPGFillProgramDataBuffer

int

EPGFillProgramDataBuffer(ppgmInfo_t pgmInfo, void* pgmData,
   int size)

EPGFillProgramDataBuffer copies the entire program data information into the specified buffer allocated by the caller. The buffer is accessed through the input void pointer *pgmData* and on successful completion of this call contains all program parameters specific to the program in *pgmInfo*. The size of the buffer is specified by the *size* parameter The actual format of the structure for passing program information is EPG specific and is transparent to MbTV modules but it would contain all the information that would be returned by multiple invocations of *EPGGetProgramParams* with valid values of *paramNum*.

The caller sets the *channelID*, and *pgmStartTime* fields of the *pgmInfo* parameter. Initialization of the *pgmInfo* structure is as described above for the *EPGGetProgramInfo* function.

On success a zero value is returned and a non zero error value otherwise.

The *pgmData* parameter is set when successful. An error is returned if the specified buffer size is less than the memory required for copying the program data information.

EPGGetProgramParamFromDataBuffer

EPGGetProgramParamFromDataBuffer(void* pgmData,

  int paramNum,

  int *paramType,

  char *paramValue)

EPGGetProgramParamFromDataBuffer returns information on the Nth parameter of the program data information specific to the program specified by contents of the input buffer *pgmData*. The value of N is specified in *paramNum*. and the contents of the pgmData buffer are initialized by an earlier call to the *EPGFillProgramDataBuffer* function.

The information returned by parameter N and the acceptable values for *paramNum* is EPG specific. *EPGGetProgramParamFromDataBuffer* returns the parameter value as a NULL terminated string and copies the string into the memory location pointed to by *paramValue* and allocated by the caller in its own memory space. The amount of memory to be allocated is EPG specific. The EPG used by the CApp and all EPG specific values and parameters are known by the PDM at compile time. The actual data type of the EPG parameter is specified in the parameter *paramType*. Acceptable value for data type are as enumerated in the *filterType_t* structure.

On success a zero value is returned and a non zero error value otherwise.

The parameter value is copied into *paramValue* parameter is set when successful.

PDM OS Support Functions

The PDM assume the availability of the following OS support functions.

OSPopen

int

OSPopen(char *fileName, int flags)

OSPopen opens the file *filename* on a persistent storage device such as hard drive or flash memory. The file is created if it does not exist. *fileName* can be an absolute or relative path name. The *flags* parameter specifies the mode in which the file is to be opened – possible modes are read-only, write-only, read-write, create, append, or truncate or any combination thereof. *OSPopen* returns a file handle which will be used for all future operations on this file.

On success it returns a non negative file handle integer. In case of error, returns -1.

OSPread

int

OSPread(int fileHndl, char *buf, size_t size)

OSPread reads *size* bytes of data from the file referred to by *fileHndl* into buffer *buf*. Caller should ensure that the buffer is big enough for *size* bytes of data. *fileHndl* should have been returned by a previous call to *OSPopen*.

On success *OSPread* returns the actual number of bytes read. In case of an EOF condition a zero is returned and in case of error a negative integer is returned.

OSPwrite

int

OSPwrite(int fileHndl, char *buf, size_t size)

OSPwrite writes *size* bytes of data to the file referred
to by *fileHndl* from buffer *buf. fileHndl* should have been
returned by a previous call to *OSPopen.*

On success return the actual number of bytes written. In
case of error, returns a negative integer.

OSPlseek

int

OSPlseek(int fileHndl, int offset, int whence)

OSPlseek repositions the offset of the file referred to
by *fileHndl* to the argument *offset* according to the directive
whence. Possible values of *whence* allow the file offset to be
repositioned at *offset* bytes, at the current file position
plus *offset* bytes or at EOF plus *offset* bytes. *fileHndl*
should have been returned by a previous call to *OSPopen*

On success return the repositioned offset in actual
number of bytes from the beginning of the file. In case of
error, returns a negative integer.

OSPclose

int

OSPclose(int fileHndl)

Close the file associated with *fileHndl.*

On success return zero and non zero error value
otherwise.

OSPprocesscreate

void *

*OSPprocesscreate(void (*pmain)(void *), void *arg, int
priority)*

OSPprocesscreate creates a new thread of execution and
place this thread in the active state. *pmain* specifies the
function to be executed when the new thread starts. *arg* is

the argument to be passed to *pmain*. *priority* specifies the initial priority for the process/thread.

On success a non-zero process/thread identifier is returned and a zero value otherwise.

OSPsetprocesspriority

signed char

OSPsetprocesspriority(signed char delta)

OSPsetprocesspriority changes the current process/thread priority by *delta* where *delta* specifies the signed value to add to the current logical priority.

It returns the resulting priority as a positive value. No error is indicated it the priority is unchanged.

OSPcriticalstart

unsigned int

OSPcriticalstart(void)

OSPcriticalstart ensures that only the calling thread may run after this call. It is used to mark the beginning of a critical section of code.

OSPcriticalstart returns previous state, which can be used for the following *OSPcriticalStop* call.

OSPcriticalstop

void

OSPcriticalstop(unsigned int prevState)

OSPcriticalstop restore previous execution state, allowing return to normal running state after a critical state. *prevState* specifies the previous state to switch back to.

CriticalStop() does not return any value.

OSPexit

void

OSPexit(int exitcode)

OSPexit kills the current process/thread by removing it from the active thread queue. All resources allocated to this thread/process are released and the next thread waiting in the active queue is activated. be Exit Status for this thread/process is passed in the parameter *code*.

OSPexit does not return any values.

OSPsleep

void

OSPsleep(int msec)

OSPsleep moves the current process/thread from the active queue to the sleeping queue and activates the next thread waiting in the active queue. *msec* specifies the maximum time duration of the sleep, in milliseconds. The process/thread will remain in the sleep state until either someone requests to wake it up or the given timeout expires.

If *msec* is 0, the process/thread will sleep until someone requests it to wakeup.

OSPsleep returned immediately if a wakeup event is pending and does not have a return value.

OSPwakeup

void

OSPwakeup(void *procId)

OSPwakeup removes the specified process/thread from the sleeping state and resume its execution. *procid* specifies the process/thread Identifier, returned by an earlier call to *ProcessCreate()*, of the process/thread to resume.

OSPwakeup does not return any value.

OSPsignal

int

OSPsignal(void *pid, int signo)

OSPsignal sends signal *signo* to the process/thread specified by *pid*.

On success a zero value is returned and a non zero value otherwise.

OSPsetsig

int

OSPsetsig (void *pid, void *handle)

OSPsetsig installs a signal handler for the process/thread specified by *pid*. *handle* specifies the signal handler to be installed.

On success a zero value is returned and a non zero value otherwise.

OSPalloc

void *

OSPalloc(int size)

OSPalloc allocates a memory block of *size* bytes.

On success returns a non zero memory address, 0 otherwise.

OSPmemfree

void

OSPmemfree(void *addr)

OSPmemfree frees the previously allocated memory block pointed to by *addr*. This address should have been returned by an earlier call to *OSPalloc* .

OSPmemfree () does not return any values.

OSPsemcreate

void *

OSpsemcreate(void)

OSpsemcreate creates a semaphore and returns the semaphore ID to be used for future semaphore operations. The initial value of the semaphore will be 0.

On success the newly created semaphore Id is returned. In case of an error it returns zero.

OSPsemdelete

void

*OSPsemdelete(void *handle)*

    OSPsemdelete deletes the existing semaphore pointed to by *handle*. This semaphore should have been allocated by a previous call to *Ospsemcreate*.

    OSPsemdelete does not return any value.

OSPsemsignal

void

*OSPsemsignal(void *handle)*

    OSPsemsignal returns a token to an existing semaphore value, and depending on the value, wakes up one process in the local process sleeping queue. *handle* specifies the semaphore identifier returned by a previous call to *OSPsemcreate.*

    OSPsemsignal does not return any value.

OSPsemwait

void

*OSPsemwait(void *handle)*

    OSPsemwait takes a semaphore token or waits until one is available. *Handle* specifies the semaphore identifier returned by a previous call to *OSPsemcreate* .

    OSPsemwait does not return any value.

OSPmesgcreate

int

OSPmesgcreate(int msgKey)

    OSPmesgcreate creates/opens a message queue associated with *msgKey*. A new message queue will be created if the *msgKey* does not have one associated with it. The maximum possible size of a message is defined by MBTV_MAX_MESG_SIZE macro.

    On success return a non negative message queue identifier. In case of error, return -1.

OSPmesgsend

int

OSPmesgsend(int msgqId, void *msgData, int length)

    OSPmesgsend sends a message *msgData* into message queue *msgqId*. *length* specifies the size of the message. The *msgData* should point to a Data buffer filled in by the caller. *length* cannot exceed MBTV_MAX_MESG_SIZE. The message queue *msgqId* should have been created by a previous call to *OSPmesgcreate*.

    On success return 0 and non zero error value otherwise.

OSPmesgrecv

Int

OSPmesgrecv(int msgqId, void *msgDataBuf, int *length)

    OSPmesgrecv reads message from message queue *msgqId* into message buffer *msgDataBuf*. The buffer should be allocated by the caller. The actual length of the message received is returned in *length*. The maximum size of a message is MBTV_MAX_MESG_SIZE. The call will block if no message is available. The message queue should have been created by a previous call to *OSPmesgcreate*.

    On Success return 0 and non zero error value otherwise.

OSPmesgdelete

void

OSPmesgdelete(int msgqId)

    OSPmesgdelete deletes message queue pointed to by *msgqId*.

    OSPmesgdelete does not return any value.

OSPreadblock

int

OSPreadblock(unsigned int blockNo, char *buf, size_t size)

    OSPreadblock reads *size* bytes of data from *blockNo* (some storage device like flash memory or hard disk) into the

data buffer *buf*. Caller should ensure that *blockNo* is big enough for *size* bytes.

This function is provided if the I/O functions for file operation are not available.

On success return the actual number of bytes read. In case of error return a negative integer and a zero value on encountering an EOF condition.

OSPwriteblock

int

*OSPwriteblock(unsigned int blockNo, char *buf, size_t size)*

OSPwriteblock writes *size* bytes of data from data buffer *buf* into block *blockNo* (some storage deice like flash memory or hard disk).

This function is provided if the I/O functions for file operation are not available.

On success return the actual number of bytes written. In case of error return a negative integer.

OSPeraseblock

int

OSPeraseblock(unsigned int blockNo)

OSPeraseblock erases a block from some storage device like flash memory or hard disk. *blockNo* specifies the block number to be erased.

This function is provided if the I/O functions for file operation are not available.

On success return zero and non zero value otherwise.

OSPtime

time_t

*OSPtime(time_t * tloc)*

OSPtime function returns the number of seconds elapsed since midnight (00:00:00), January 1, 1970, Coordinated

Universal Time. A copy of the time value is stored in the location given by *tloc*. If *tloc* is NULL, no value is stored.

On success *OSPtime()* returns the value of time. Otherwise a value of (time_t) -1) is returned.

OSPmktime

time_t

*OSPmktime(struct tm * tmptr)*

OSPmktime function converts the broken down time, expressed as local time, in the structure pointed to by *tmptr* into a **time_t** calendar time value. The converted time has the same the same encoding as the values returned by *OSPtime()* function.

The functionality of *OSPmktime()* is as defined by ANSI *mktime()* function.

On success *OSPmktime()* returns the converted time. Otherwise a value of (time_t) -1) is returned.

OSPgmtime

*struct tm *t*

*OSPgmtime(time_t *clock, struct tm * tmptr)*

OSPgmtime function converts the time value (specified in **time_t** format) pointed at by clock, and returns a pointer to a "struct tm" which contains the broken-out time information. No time zone conversions are done by *OSPgmtime()*. If pointer *tmptr* is non-NULL, it is filled with the broken-out time information.

The functionality of *OSPgmtime()* is as defined by ANSI *gmtime()* function.

OSPlocaltime

*struct tm *t*

*OSPlocaltime(time_t *clock, struct tm * tmptr)*

OSPlocaltime function converts the time value (specified in **time_t** format) pointed at by clock, and returns a pointer

to a "struct tm" which contains the broken-out time information for the value, after adjusting for the current time zone and any other factors such as Daylight Saving Time. If pointer *tmptr* is non-NULL, it is filled with the broken-out time information.

The functionality of *OSPlocaltime()* is as defined by ANSI localtime*()* function.

On success *OSPlocaltime()* returns the pointer to converted time. Otherwise NULL is returned.

OSPgettimezoneoffset

int

OSPgettimezoneoffset()

OSPgettimezoneoffset function returns the difference between Universal Coordinated Time and local time, expressed in seconds. This function will return a negative offset for time zones east of GMT.

This function is provided if other time manipulation functions are not available.

OSPgetDSTinfo

int

OSPgetDSTinfo()

OSPgetDSTinfo function returns a non-zero value if daylight savings time is in effect for the current location. Otherwise it returns zero.

This function is provided if other time manipulation functions are not available.

PDM Modules

The PDM, as shown in Fig. 44, comprises a number of modules, including the Internal EPG Module (IEPG), the Profile Identification Module (PIM), the Viewer Recording Module (VRM), the Category Database Module (CDM), the Viewer Status Module (VSM), and the String Table Manager (STM). In

addition, an API must be provided to interface between the PDM and the CApp, as well as between the SDM and the CApp.

MbTV OS API

The Public Interface Functions and Macros, as listed and defined below, are declared in include/mbtvos_p.h.

```
#define MAX_MESG_SIZE      64
int OSPopen(char *fileName, int flags);
int OSPread(int fd, char *buf, size_t size);
int OSPwrite(int fd, char *buf, size_t size);
int OSPlseek (int fd, int offset, int whence);
int OSPclose(int fd);
void *OSPprocesscreate(void (*pmain)(void *), void *arg, int priority);
char OSPsetprocesspriority(char delta);
unsigned int OSPcriticalstart(void);
void OSPcriticalstop(unsigned int prevState);
void OSPexit(int exitCode);
void OSPsleep(int msec);
void OSPwakeup(void *procId);
int OSPsignal(void *pid, int signo);
int OSPsetsig(void *pid, void *handle);
void *OSPalloc(int size);
void OSPmemfree(void *addr);
void OSPsemcreate(int semKey, /* int semVal */ …);
void OSPsemdelete(void *handle);
void OSPsemsignal(void *handle);
void OSPsemwait(void *handle);
void * OSPmesgcreate(int msgKey, /* int msgSize */ …);
int OSPmesgsend(void *msgqId, void *msgData, int length);
int OSPmesgrecv(void *msgqId, void *msgDataBuf, int *length);
void OSPmesgdelete(void *msgqId);
time_t OSPtime(time_t *tloc);
```

```
time_t OSPmktime(struct tm *tmptr);
```

```
struct tm *OSPgmtime(time_t *clock, struct tm *tmptr);
```

```
struct tm *OSPlocaltime(time_t *clock, struct tm *tmptr);
```

Name

OSPopen

Synopsis

```
#include <include/mbtvos_p.h>
```

```
int OSPopen(char *fileName, int flags);
```

Description

OSPopen() opens the file filename on a persistent storage device such as hard drive or flash memory. The file is created if it does not exist. fileName can be an absolute or relative path name.

The flags parameter specifies the mode in which the file is to be opened. Possible modes are read-only, write-only, read-write, create, append, or truncate or any combination thereof.

Return value

On success, returns a file handle which will be used for all future operations on this file. In case of error, returns -1.

Name

OSPread

Synopsis

```
#include <include/mbtvos_p.h>
```

```
int OSPread(int fd, char *buf, size_t size);
```

Description

OSPread() reads size bytes of data from the file referred to by file handle fd into buffer buf. Caller should ensure that the buffer is big enough for size bytes of data.

Return value

On success OSPread() returns the actual number of bytes read. In case of an EOF condition a zero is returned and in case of error a negative integer is returned.

Name

OSPwrite

Synopsis

#include <include/mbtvos_p.h>

int OSPwrite(int fd, char *buf, size_t size);

Description

OSPwrite() writes size bytes of data to the file referred to by file handle fd from buffer buf.

Return value

On success return the actual number of bytes written. In case of error, returns a negative integer.

Name

OSPlseek

Synopsis

#include <include/mbtvos_p.h>

int OSPlseek (int fd, int offset, int whence);

Description

OSPlseek() sets the offset in the file referred to by file handle fd to the argument offset according to the directive whence. Possible values of whence allow the file offset to be set at offset bytes from the beginning, from the current offset or from the EOF.

Return value

On success return the new offset in actual number of bytes from the beginning of the file. In case of error, returns a negative integer.

Name

OSPclose

Synopsis

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```
#include <include/mbtvos_p.h>
int OSPclose(int fd);
```

Description

Close the file associated with fd.

Return value

Returns 0 on success, non-zero otherwise.

Name

OSPprocesscreate

Synopsis

```
#include <include/mbtvos_p.h>
void * OSPprocesscreate(void (*pmain)(void *),
                        void *arg, int priority);
```

Description

OSPprocesscreate() creates a new thread of execution and places this thread in the active state. pmain specifies the function to be executed when the new thread starts. arg is the argument to be passed to pmain.

priority specifies the initial priority for the process/thread.

Return value

On success a non-zero process/thread identifier is returned and a zero value otherwise.

Name

OSPsetprocesspriority

Synopsis

```
#include <include/mbtvos_p.h>
char OSPsetprocesspriority(signed char delta);
```

Description

OSPsetprocesspriority() changes the current process/thread priority by delta where delta specifies the signed value to add to the current logical priority.

Return value

Returns the resulting priority as a positive value. No error
is indicated if the priority is unchanged.

Name

OSPcriticalstart

Synopsis

#include <include/mbtvos_p.h>

unsigned int OSPcriticalstart(void);

Description

OSPcriticalstart() ensures that only the calling thread may
run after this call. It is used to mark the beginning of a
critical section of code. (Internally it is implemented using
OSPsetprocesspriority() call to set the highest priority to
the calling thread.)

Return value

Returns previous state, which can be used for the
following OSPcriticalstop() call.

Name

OSPcriticalstop

Synopsis

#include <include/mbtvos_p.h>

void OSPcriticalstart(unsigned int prevState);

Description

OSPcriticalstop() restore previous execution state, allowing
return to normal running state after a critical state.
prevState specifies the previous state to switch back to.
(Internally it is implemented using the
OSPsetprocesspriority() call to set the previous priority
value to the calling thread.)

Return value

None.

Name

OSPexit

Synopsis

#include <include/mbtvos_p.h>

void OSPexit (int exitCode);

Description

OSPexit() terminates the current process/thread.
Exit status for this thread/process is passed in the
parameter exitCode.

Return value

None.

Name

OSPexit

Synopsis

#include <include/mbtvos_p.h>

void OSPexit (int exitCode);

Description

OSPexit() terminates the current process/thread.
Exit status for this thread/process is passed in the
parameter exitCode.

Return value

None.

Name

OSPsleep

Synopsis

#include <include/mbtvos_p.h>

void OSPsleep (int msecs);

Description

OSPsleep() function suspends execution of the calling
thread/process for msec milliseconds. The process/thread will
remain in the sleep state until either someone requests to
wake it up or the given timeout expires. If msec is 0, the
process/thread will sleep until someone requests it to
wakeup.

OSPsleep() returns immediately if a wakeup event is pending.

Return value

None.

Name

OSPwakeup

Synopsis

#include <include/mbtvos_p.h>

void OSPwakeup(void *procId);

Description

OSPwakeup() wakes up the process/thread specified by

the its process/thread identifier procId.

Return value

None.

Name

OSPsignal

Synopsis

#include <include/mbtvos_p.h>

int OSPsignal(void *pid, int signo);

Description

OSPsignal() sends signal signo to the process/thread

specified by pid.

OSPsignal() function is used to notify a thread waiting in

OSPsleep() function that some event has occured.

Note: The only signal implemented is SIGALARM.

Return value

On success, returns 0 and a non zero value otherwise.

Name

OSPsetsig

Synopsis

#include <include/mbtvos_p.h>

int OSPsetsig(void *pid, void *handle);

Description

OSPsetsig() installs a signal handler specified by handle
argument for the process/thread specified by pid.
The signal handle is semaphore handle which then is used by
OSPsleep and OSPwakeup() functions to implement sleep/wakeup
functionality.
Note: Don't use semaphores which protect some common data as
signal handlers.
Return value

On success, returns 0 and a non zero value otherwise.
Name

OSPalloc

Synopsis

#include <include/mbtvos_p.h>
void * OSPalloc(int size);
Description

OSPalloc() allocates a memory block of size bytes.
Return value

On success, returns a non zero memory address, 0 otherwise.
Name

OSPmemfree

Synopsis

#include <include/mbtvos_p.h>
void OSPmemfree(void *addr);
Description

OSPmemfree() frees the previously allocated memory block
pointed to by addr. This address should have been returned by
an earlier call to OSPalloc().
Return value

None.

Name

OSPsemcreate

Synopsis

#include <include/mbtvos_p.h>

void OSPsemcreate(int semKey, /* int semVal */ …);

Description

OSPsemcreate() creates/opens a semaphore associated with semKey. A new semaphore will be created if the msgKey does not have one associated with it. The initial value of the semaphore will be set (if provided) for newly created one. Otherwise it will be a current value.

Return value

On success semaphore Id is returned. In case of an it returns NULL.

Name

OSPsemdelete

Synopsis

#include <include/mbtvos_p.h>

void OSPsemdelete(void *handle);

Description

OSPsemdelete() deletes the existing semaphore pointed to by handle.

Return value

None.

Name

OSPsemsignal

Synopsis

#include <include/mbtvos_p.h>

void OSPsemsignal(void *handle);

Description

OSPsemsignal() signals to semaphore specified by handle to increment current semValue by 1. If semValue becomes greater then 0 one of the threads waiting on this semaphore resumes its execution.

Return value

None.

Name

OSPsemwait

Synopsis

#include <include/mbtvos_p.h>

void OSPsemwait(void *handle);

Description

OSPsemwait() waits until current semValue of the semaphore specified by handle becomes greater then 0, then it decrements semValue and resumes thread execution.

Return value

None.

Name

OSPmesgcreate

Synopsis

#include <include/mbtvos_p.h>

void *OSPmesgcreate(int msgKey, /* int msgSize */ …);

Description

OSPmesgcreate() creates/opens a message queue associated with msgKey. A new message queue will be created if the msgKey does not have one associated with it. The optional msgSize argument defines the size of the message queue buffer. The maximum (default) size of a message is defined by MAX_MESG_SIZE macro.

Return value

On success returns message queue identifier.

Name

OSPmesgsend

Synopsis

#include <include/mbtvos_p.h>

int OSPmesgsend(void *msgqId, void *msgData, int length);

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Description

OSPmesgsend() sends a message msgData into message queue
msgqId.

length specifies the size of the message. The msgData should
point to a Data buffer filled in by the caller. The length
cannot exceed MAX_MESG_SIZE.

Return value

Returns 0 if success and non zero otherwise.

Name

OSPmesgrecv

Synopsis

#include <include/mbtvos_p.h>

int OSPmesgrecv(void *msgqId, void *msgDataBuf, int *length);

Description

OSPmesgrecv() reads message from message queue msgqId into
message buffer msgDataBuf. The buffer should be allocated by
the caller. The actual length of the message received is
returned in length. The maximum size of a message is
MAX_MESG_SIZE.

The call will block if no message is available.

Return value

Returns 0 if success and non zero otherwise.

Name

OSPmesgdelete

Synopsis

#include <include/mbtvos_p.h>

void OSPmesgdelete(void *msgqId);

Description

OSPmesgdelete() deletes message queue pointed to by msgqId.

Return value

None.

Name

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OSPtime

Synopsis

#include <include/mbtvos_p.h>

time_t OSPtime(time_t * tloc);

Description

OSPtime() function returns the number of seconds elapsed
since midnight (00:00:00), January 1, 1970, Coordinated
Universal Time. A copy of the time value is stored in the
location given by tloc. If tloc is NULL, no value is stored.

Return value

On success, returns the value of time. Otherwise the value of
(time_t) -1) is returned.

Name

OSPmktime

Synopsis

#include <include/mbtvos_p.h>

time_t OSPmktime(struct tm * tmptr);

Description

OSPmktime() function converts the broken down time, expressed
as local time, in the structure pointed to by tmptr into a
time_t calendar time value. The converted time has the same
encoding as the values returned by OSPtime() function. The
functionality of OSPmktime() is as defined by ANSI mktime()
function.

Return value

On success, returns the value of time. Otherwise the value of
(time_t) -1) is returned.

Name

OSPgmtime

Synopsis

#include <include/mbtvos_p.h>

struct tm * OSPgmtime(time_t *clock, struct tm * tmptr);

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Description

OSPgmtime() function converts the time value (specified in time_t format) pointed at by clock, and returns a pointer to a "struct tm" which contains the broken-out time information. No time zone conversions are done by OSPgmtime(). It fills tmptr with the broken-out time information. The functionality of OSPgmtime() is as defined by ANSI gmtime() function. The argument tmptr must be a valid pointer.

Return value

On success, returns tmptr value. Otherwise NULL.

Name

OSPlocaltime

Synopsis

#include <include/mbtvos_p.h>

struct tm * OSPlocaltime(time_t *clock, struct tm * tmptr);

Description

OSPlocaltime() function converts the time value (specified in time_t format) pointed at by clock, and returns a pointer to a "struct tm" which contains the broken-out time information for the value, after adjusting for the current time zone and any other factors such as Daylight Saving Time. It fills tmptr with the broken-out time information. The functionality of OSPlocaltime() is as defined by ANSI localtime() function. The argument tmptr must be a valid pointer.

Return value

On success, returns tmptr value. Otherwise NULL.

Internal EPG Module

The Internal EPG Module (EM) maintains EPG information for all programs provided by the External EPG in an internal database for the time for which the TV is in "POWER ON" mode. The amount of information maintained by the EM is configurable. Depending on the configuration, the EM might

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store all the fields of the EPG information or a number of selected fields. The information stored in this module is used for further processing by other several internal modules. This processing by other internal MbTV modules is done as a part of a background task and is typically done at a much later time. The EPG information needs to be saved by EM as EPG libraries currently provide information on programs currently or in the future. Each program is stored by the EM in the form of EPG record in an internal database. The size of the EM EPG record is variable as not all parameters are available for all programs. The variable size of the EPG record is also used in order to reduce the memory required for the internal database. The EM provides supporting functions which allow the insertion, deletion, and retrieval of EM EPG records. Retrievals are based on getting EPG records for a specific time.

EPG parameters are typically in the form of strings. As EPGs typically contain a lot of repetitive data the same set of strings might appear in the EPG parameters of a number of programs. When storing EPG records in the EM database, all strings associated with the EPG record are first inserted in a string Table. For each string inserted in the String Table, an index is returned. The EM in lieu of the actual string uses this index when storing EPG records in the EMs internal database. The same index is returned when a string is stored multiple times in the String Table.

Internal data structures

The C data structure defined by EM is described below.

epgRec_t

```
typedef struct
{
    time_t      pgmStartTime;
```

```
    ushort          pgmDuration;
    uint            mask :24;
    uint            len  :8;
    mbtv_t          ptrs[24];
} epgRec_t;
```

The semantics of the fields in the above structure is the following.

- pgmStartTime stores the start time of the program in GMT format.

- pgmDuration stores the duration of the program in minutes.

- mask indicates which categories of epg information of this program is available in the current record. Each bit of 24 bits corresponds to a category of epg information of the program. If a bit of this variable is set to 1, there is a string pointer to its category in ptrs.

- len has the total length of a epg record in byte. Using this value, the number of bits whose value are set to 1 can be calculated.

- ptrs is an array of the string pointer. The size of this array is variable according to the value of mask. The size of the epgRec_t is also variable because of ptrs.

epgDb_t

```
typedef struct
{
    uint        size;
    uint        maxSize;
    ushort      del;
    char        *data;
} epgDb_t;
```

The semantics of the fields in the above structure is the
following.

- size is the current size of epg database that is
  occupied by epg records.
- maxSize the total size of the data memory that is
  allocated for epg database.
- del indicates the number of epg records that is marked
  as deleted.
- data points the base address of the memory that is
  allocated for epg database.

Basic functionality

The insertion of EPG record to database

If a program is to be added to the internal data base,
the EPG information for the program is first obtained from
the External EPG library. All strings associated with EPG
parameters of interest are first stored in string table. The
index associated with the string in string table is stored in
ptrs field of the EPG record and the bit corresponding to its
EPG field in mask of the record is set to 1. EPG Parameters
that do not carry any information for a specific record are
not stored and the corresponding mask bit in the EPG record
is set to 0.

The deletion of EPG record from database

If an EPG record is to be deleted, pgmStartTime of the
EPG record is set to 0 and del in EPG database header is
increased. All strings pointed by ptrs are deleted from the
string tables. When del is greater than pre-determined value,
the compaction mechanism of EPG database is executed.

The retrieval of EPG record from database

The internal EPG database stores channel associated with
a program in the internal database by the string index
returned for the channel name. During retrieval the channel

ID passed by caller is converted into the string index associated with the channel name in string tables. The pointer to channel name in ptrs, pgmStartTime, and pgmDuration are used to search the EPG record of the program that is requested.

Data structures accessed by this module

- Program Info structure in pgm.h : pgmInfo_t, ppgmInfo_t
- MbTV string pointer structure in types.h : mbtv_t
- Structure for readLn() in mbtvos.h: fdbuf_t

Interface functions of this module

int EMInit(void)

Description : Initializes and starts the EM. This routine performs memory allocation and semaphore creation.

Returns : 0 is returned on SUCCESS and 1 is returned on FAIL.

Note : none

int EMGetNextCompetingPrgm(pgmInfo_t *pgmInfo,

int   scanMode,

void **context,

int   force)

Description : This function returns information on a program that competed with the program specified by channelID, pgmStartTime and pgmDuration in pgmInfo. Actually pgmStartTime has viewing start time and pgmDuration has viewing duration. A program is considered to be a competing program if it was available within time span covered by the pgmStartTime and pgmDuration. If a viewing record has N competing programs, this function has to be called N times to get program information on each of the N programs.

On input the caller sets the channelID, pgmStartTime, and pgmDuration from the viewer record. In the first call of each viewer record, the context parameter is set to NULL. On

subsequent calls it is set to the value returned in the preceding call to this function.

On output this function sets the channelID, pgmStartTime and pgmDuration in pgmInfo. If there are no more programs, pgmStartTime field is set to 0.

The context parameter is used by this function to store some context information so that subsequent call to this function will use this information to return the next competing program. The calling program should not modify the context parameter.

The scanMode parameter is used to set the order in which the competing programs are returned. Possible values for scanMode are SCAN_TIMEWISE and SCAN_CHANNELWISE. But currently only SCAN_TIMEWISE is supported.

The force parameter is used to restrict the search for competing programs to subscribed channels if the channel is CHANNEL_TYPE_PREMIUM. If force parameter is set to 1, there is no restriction on the search of competing programs. If force parameter is set to 0, programs that belong to channels that are CHANNEL_TYPE_PPV or channels that are CHANNEL_TYPE_PREMIUM and not subscribed are excluded from competing programs.

Returns : 0 is returned on SUCCESS and 1 is returned on FAIL.

Note : This function is *not safe in multi-thread environment* because of the context parameter. Currnetly there is only one place at which this function is called.

int EMGetProgramInfo(pgmInfo_t *pgmInfo, epgRec_t **pRec)

Description : This function returns information of the program that is found by channelID, pgmChannelType, and pgmStartTime in pgmInfo. A program is found if pgmStartTime falls on the time span that belongs to the program in EPG

database. If pgmChannelType is CHANNEL_TYPE_VIRTUAL,
SDMGetProgramInfo() is called with pgmInfo parameter. If
pgmStartTime is greater than start time of the latest program
in EPG database, EPGGetProgramInfo() is called with pgmInfo
parameter. On input if pRec is NULL, target program is
searched from the start of EPG database. If it is not NULL,
program is searched from the position it has.
On output if matched program is found, pgmStartTime,
pgmDuration, and pRec is updated with the program found. If
there is no match, information of the next available program
is returned and pRec is set to NULL. If next available
program does not exist, prmStartTime is set to 0.
Returns : 0 is returned on SUCCESS and 1 is returned on FAIL.
Note : none

int EMGetProgramParams(pgmInfo_t   *pgmInfo,
                                        int   paramNum,
                                        int   *cntParam,
                                        mbtv_t   *strPtr)

Description : Sets up the strPtr to point to the string
associated with the paramNum for the program specified by the
pgmInfo.

On input the caller sets the channelID and pgmStartTime
fields of the pgmInfo. paramNum is set to indicates category
number to get the string and optionally cntParam is set to
indicate string number in paramNum category that is multi-
string category.

On output if cntParam is set to -1, the first string of
the paramNum is returned. If it is set to N(≥ 0), the Nth
string of the paramNum is returned. If cntParam is set to -1,
cntParam returns the number of strings associated with the
paramNum.

Returns : 0 is returned on SUCCESS and 1 is returned on FAIL.

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Note : none

int EMSetRecBuffer(pgmInfo_t *pgmInfo, epgRec_t *epgRec, int force)

Description : This function fills the internal EPG record that is pointed by epgRec with information using pgmInfo. Each string from the program of the pgmInfo is added to a string table and epgRec is filled with program and string information. If the same program already exists in EPG database, the existing record is copied to epgRec and the reference count of each string of the record is increased in string tables.

On input the caller sets channelID and pgmStartTime in pgmInfo.

On output if there is no program at pgmStartTime in EPG data, pgmInfo is returned with the information of fake program. pgmDuration is set to the difference of pgmStartTime and the start time of next available program.

The force parameter is used to restrict the program that can be inserted to EPG database. If force is set to 1, every program can be inserted. If force is set to 0, the program that belongs to the channel of CHANNEL_TYPE_PPV or the channel that is CHANNEL_TYPE_PREMIUM and not subscribed is excluded from the insertion to the EPG database.

Returns : 0 - SUCCESS

           1 - if there is a hole in EPG data.

           2 - others.

Note : none

int EMGetRecBufferParams(epgRec_t   *epgRec,

                             int   paramNum,

                             int   *cntParam,

                             mbtv_t   *strPtr)

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Description : Sets up the strPtr to point to the string
associated with the paramNum for the program specified by the
epgRec.

On input if cntParam is set to -1, the first string of
the paramNum is returned. If it is set to N(>0), the Nth
string of the paramNum is returned.

On output if cntParam is set to -1, cntParam returns the
number of strings associated with the paramNum.
Returns : 0 is returned on SUCCESS and 1 is returned on FAIL.
Note : none

int EMDelRecBuffer(epgRec_t *epgRec)

Description : This function clears the EPG record specified
by epgRec and all strings releated to this record is deleted
from the string tables. But the memory of this record is not
returned to the system.
Returns : 0 is returned on SUCCESS and 1 is returned on FAIL.
Note : none

int EMCopy(time_t startTime, time_t stopTime, int firstCopy)

Description : This function copies external EPG data into
internal EPG database and updates the channel line-up if it
is enabled.

On input caller sets the startTime, stopTime, and
firstCopy.

The firstCopy is used to select EPG programs that is to
be copied into the internal database. If firstCopy is 1, only
programs that are available within the time span specified by
startTime and stopTime are copied into the internal database.
If firstCopy is 0, only programs that start after startTime
and before stopTime are copied into the internal database.
Returns : 0 is returned on SUCCESS and 1 is returned on FAIL.
Note : none

int EMDelAfter(time_t time)

Description : Deletes from EPG database all EPG records whose
pgmStartTime is greater than or equal to time. All strings
related to these records are deleted from the string tables.

Returns : 0 is returned on SUCCESS and 1 is returned on FAIL.

Note : none

int EMDelBefore(time_t time)

Description : Deletes from EPG database all EPG records whose
program ends before time. All strings related to these
records are deleted from the string tables.

Returns : 0 is returned on SUCCESS and 1 is returned on FAIL.

Note : none

4.9   int EMAddSubscrChannel(void *channelID, int addType,
time_t viewTime)

Description : Adds a channel to the list of subscribed
channel in EM.

On input caller sets channelID, addType, and viewTime.
The addType parameter is used to specify the method by which
a channel is added to the list of subscribed channel.
Possible values for addType are:

EXPLICIT_ADD - This type is given by TV viewer through
user interface.

IMPLICIT_ADD - This type is given by internal module of
PDM.

If the channel was already in the list, viewTime is
updated and addType is compared with the type in the list. If
the type in the list is IMPLICIT_ADD and addType in input is
EXPLICIT_ADD, the type in the list is set to EXPLICIT_ADD.
The viewTime parameter is used to specify the time at which
this program was watched. If viewTime is 0, current time is
used. Internally viewTime is converted to the time at which
this channel is to be deleted from the list of subscribed

channel. If a subscribed channel is not updated for some period from outside, it will be deleted from the list after the fixed amount of time passes.

Returns : 0 is returned on SUCCESS and 1 is returned on FAIL.

Note : This function can be called after EMLockSubscrChannelList() and before EMUnlockSubscrChannelList().

int EMDeleteSubscrChannel(void * channelID)

Description : Deletes a channel specified by channelID from the list of subscribed channel.

Returns : 0 is returned on SUCCESS and is returned on FAIL.

Note : This function can be called after EMLockSubscrChannelList() and before EMUnlockSubscrChannelList().

int EMGetNumberOfSubscrChannels(int *numSubscrChannels)

Description : Returns the number of subscribed channel in the list.

Returns : Always 0

Note : This function can be called after EMLockSubscrChannelList() and before EMUnlockSubscrChannelList().

int EMGetSubscrChannelID(int subscrChanIndex, void **channelID)

Description : Returns the channel ID specified by the index of subscrChanIndex in the list of subscribed channel. Before calling this function, caller should call EMGetNumberOfSubscrChannels() to get the total number of the channel in the list. On output channel ID is returned through channelID parameter.

Returns : 0 is returned on SUCCESS and 1 is returned on FAIL.

Note : This function can be called after
EMLockSubscrChannelList() and before
EMUnlockSubscrChannelList().

int **EMLockSubscrChannelList (void)**

Description : Tries to get the semaphore of the subscribed
channel list. Anybody who wants to access subscribed channel
list should call this function at the beginning and
EMUnlockSubscrChannelList() at the end.

Returns : Always 0

Note : The time interval between EMLockSubscrChannelList()
and EMUnlockSubscrChannelList() should be as short as
possible.

int **EMUnlockSubscrChannelList (void)**

Description : Releases the semaphore, which enables another
thread to access subscribed channel list. . This function is
called after EMLockSubscrChannelList().

Returns : Always 0

Note : The time interval between EMLockSubscrChannelList()
and EMUnlockSubscrChannelList() should be as short as
possible.

int **EMGetNumChannels(int *numChannels)**

Description : Returns the number of channels in the current
channel line-up. Channel line-up can be changed with time.

Returns : Always 0.

Note : This function can be called after
EMUnlockChannelIDList() and before EMUnlockChannelIDList().

int **EMGetChannelID(int channelIndex, void**
****channelID)**

Description : Returns the channel ID specified by the index
of channelIndex. After getting the number of channels through
EMGetNumChannels(), caller calls this function.

Returns : Always 0.

Note : This function can be called after
EMUnlockChannelIDList() and before EMUnlockChannelIDList().

int **EMLockChannelIDList(void)**

Description : Tries to get the semaphore of the channel line-
up. Anybody who wants to access current channel line-up from
EM should call this function at the beginning and
EMUnlockChannelIDList() at the end.

Returns : Always 0

Note : The time interval between EMLockChannelIDList() and
EMUnlockChannelIDList() should be as short as possible.

int **EMUnlockChannelIDList(void)**

Description : Release the semaphore, which enables EM to
update channel line-up. This function is called after
EMLockChannelIDList().

Returns : Always 0

The time interval between EMLockChannelIDList() and
EMUnlockChannelIDList() should be as short as possible.

Interface functions accessed by this module

- Related to string table :
  - STAddRec()
  - STDelRec()
  - STSearch()
  - STGetStrPtr() : MBTV_GET_STRING()
- Related to CDM :
  - CDMGetCategoryInfo()
- Related to time :
  - mktime()
  - localtime_r()
- Related to external epg data :
  - EPGGetChannelID()
  - EPGGetProgramInfo()
  - EPGGetNumChannels()

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- EPGGetChannelParams()

- EPGGetChannelIDFromName()

● Related to semaphore :

- SemCreate()

- SemWait()

- SemSignal()

● Related to memory allocation

- AllocateMemory()

- FreeMemory()

● Related to IO manager :

- readLn()

● Related to SDM :

- SDMGetProgramInfo()

String Table Manager

The String Table Manager (STM) is used to store strings required by various internal modules of the PDM. The internal modules that currently use the String Table are the EM and the CDB. The STM internally allocates a number of String Tables to store strings of various lengths. For example the STM might allocate 4 string tables where each string table could hold up to a maximum of 100 strings each. Each string table is used to store strings that are less than or equal to a specified length. The size of a string table could thus be used to refer to the size of the string that could be stored in the string table. The first string table could be used for all strings which are less than or equal to 30 characters long, the second string table could be used to store strings which are less than or equal to 60 characters long & so on. The STM stores any given string in the string table with the smallest possible size. If there is no space available in that string table, it tries to fit it in the next smallest string table. The STM returns a String Table ID (STID) for

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each string inserted in the string table. The STID is derived from the position of the string in the string table and which string table it is inserted in. Since the number of strings that can be stored in a string table is fixed, the STID returned by the STM could be used to determine which string table was used to store a string and the position of the string in the string table. If a string is inserted in the string table multiple times, the same STID is returned by the STM.

The STM provides basic functionality for string insertion, deletion & retrieval.

String Insertion

The STM first determines if the string is already inserted in a string table. If the string is already inserted, the STM returns the STID for the string and increments the reference count for that string by 1. If the string is not already inserted, it fits it in the smallest possible string table and in the first free location within the string table and set the reference for the string to 1 and returns the STID generated from the location where the string is inserted.

String Deletion

To delete a string, the caller provides the STID of the string to be deleted. The STM decrements the references count by 1. If the reference count becomes 0 the location occupied by the string becomes free and is available for insertion of a new string.

String Access

The STM provides support for string searches in the String Table. Based on the string size, the STM searches the smallest string table that could accommodate the string. If the string is not found in that table the next smallest table

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is searched. This process is continued till the string is found or not depending on whether the string was stored in the string table.

For each string table allocated by the STM, it maintains a separate sorted list of all strings in the string table. This sorted list is updated whenever a new string is inserted or when the reference count of a deleted string becomes 0. When searching for a string in a string table the STM uses this sorted list to optimize the string search.

<u>Profile Identification Module</u>

The PIM is responsible for creating and maintaining cluster information. In this document terms "Cluster" and "Profile" are used interchangeably. The PIM is also responsible for computing profile mix at given time. Thus, the PIM performs three functions:

- Maintaining a list of events
- Updating/Creating clusters
- Computing profile mix

The PIM receives events from the Viewer Record Module (VRM) and saves them in a data structure. Further, it uses this data to either update clusters or to compute profile mix.

Architecture

<u>Maintaining a list of events</u>

As shown in Figure 45, the VRM receives events such as *channel change* from the CApp and passes them down to the PIM. These events are passed using the cBackInfo_t structure. VRM passes the same structure to PIM.

The VSM keeps track of viewer's activities and generates *power off* event if there is no viewer activity for a pre-defined period. The VSM passes this event to VRM using

cBackInfo_t structure. The VRM passes the same structure to the PIM.

Internally, the PIM saves all the events in a structure "PimEventList". Each of the events in this list is of type PIMEventRec. PIMEventRec is described below.

```
typedef struct _PIMEventRec_
{
    ushort        type;
    ushort        timeDiff;
    ushort        epgTimeDiff;
    union _param1_
    {
        void*       channelID;
        time_t      epochTime;
        ulong       profileID;
        int         probability;
    } param1;
} PIMEventRec;
```

In the above structure,

- *type* : Provides type of the event. Example of an event type if *PIM_CHANNEL_CHANGE.*

- *timeDiff* : This variable is used to compute time when the event was generated.

- *epgTimeDiff* :This variable is used to find out the program being watched at the time of event generation.

- *param1* : Depending on event type, param1 holds one of the four variables described below.

    channelID : If the event is generated as a result of *channel change* event then this variable holds id of the current channel.

    epochTime : This variable, in conjunction with timeDiff and epgTimeDiff, lets PIM compute the event time.

profileID : If the event is of type *profile login* or
profile logout, this variable provides id of the
profile.

probability : If the event is of type profile mix, this
variable provides probability of profiles that were
active at the time of event generation.

Updating/Creating clusters

Figure 46 describes the process of creating/updating
clusters.

The PDM Thread (a.k.a. PDM background thread) performs
various housekeeping operations for the PDM. One of the
operations is to call a function of the PIM that
creates/updates clusters.

Sub-module *Cluster Generation* (shown in Figure 45)
performs three steps:

1.   Divide PIMEventList into various viewing sessions

2.   Learn parameters of viewer's interest, per session,
      using events

3.   Update clusters using EM clustering algorithm. This
      algorithm uses the information generated in step 2. For
      each cluster, the algorithm computes average liking and
      variation of various parameters.

Example: Assume Cluster Generation learns only about
sets of channels watched during various viewing sessions
(step 2). The EM algorithm then creates clusters of channels
where each cluster reflects behavior of a profile. In other
words, a set of channels in a cluster reflects liking of that
cluster.

Computing the profile mix

Figure 47 describes the process of profile mix
computation. It also shows how other modules use the profile

mix. The profile mix gives the probability of any profile being active at the given time.

The PDM thread periodically calls a function of the PIM to compute the profile mix. The PIM, using the clusters it created during the process as described previously, and viewer events of the current viewing session, computes the profile mix. The PIM accesses the events occurred during the current viewing session from PIMEventList.

Computing the profile mix entails the following steps:

1.   Divide PIMEventList into various viewing sessions

2.   Use events from the curent viewing session to learn viewer's liking for various parameters.

3.   Compare these liking values with all the clusters' liking values (as computed in section "Clustering Generation"). Compute probability of each cluster being active for the current session.

While computing current profile mix, PIM takes into consideration the explicit *login* or *logout* actions taken by the viewer.

Example: Assume there are 3 active clusters in the system. Based on events received, the PIM computes the profile mix to be {0.3, 0.6, 0.1} for a set of profiles {Profile 1, Profile 2, Profile 3}. Let us also assume that profile 1 explicitly logged in. Because of explicit login the probability of Profile 1 being active increases. Thus the resultant profile mix for the given set becomes {0.1, 0.85, 0.05}.

The effect of explicit login reduces with time. This way, the PIM can take care of the situation where a profile logs in but the subsequent viewer events reflect absence of this profile.

Usage of the Profile Mix

The Category Database Module (CDM) and CApp use the profile
mix for various purposes.

- Get best programs: As shown in Figure 47, CApp calls a
  function of CDM to get N best programs (or MbTV picks).
  The CDM returns a list of programs that includes
  programs of different profiles' liking. To decide the
  number of programs for a particular profile, the CDM
  uses profile mix provided by the PIM.

  Example: Assume CApp calls the CDM function to get
  the 10 best programs. The CDM gets current profile mix
  from the PIM. Assume the mix is {0.2, 0.7, 0.1}
  corresponding to a profile set {profile 1, profile 2,
  profile 3}. In this case, the CDM returns a list of
  programs that includes 2 programs of profile 1's liking,
  7 programs of profile 2's liking and 1 program of
  profile 3's liking.

- Update CDM database: At the time of viewer record
  generation, VRM gets the current profile mix from PIM.
  It put this mix in every viewer record it generates.

  As shown in Figure 3, the PDM thread calls a
  function of the CDM to update the CDM database. This
  function learns about the viewer's interests. To perform
  this operation it uses viewer records generated by the
  VRM. For each viewing record, the CDM updates the liking
  of profiles based on the profile mix stored in the
  viewing record.

  Example: Assume a profile mix stored in a viewing
  record is{0.1, 0.9, 0.0} corresponding to a profile set
  {profile 1, profile 2, profile 3}. In this case, the CDM
  does not update liking of profile 3 and updates liking
  of profile 1 and profile 2 based on their respective
  probabilities.

PIM Functions

- int VIMGetProfileMix(float *profioleMix)

  This function call can be used to get the profile mix.

- int VIMNotify(viewRec_t *viewRec, cBackInfo_t cBack);

  This function is called by VRM to pass all the events to VIM.

- int VIMProfileLogin(int id)

  This function is called at the time of explicit login. Note that this function accepts profile id for logging in and not viewer id.

- int VIMProfileLogout(int id)

  This function is called at the time of explicit logout.

- int VIMComputeProfileMix()

  VIMComputePofileMix is called by PDM housekeeping thread. This function computes profile mix. It function should be called periodically (every 10 to 30 minutes).

- int VIMComputeClusters()

  VIMComputeClustes is called by PDM housekeeping thread. This function computes/updates clusters. This function should be called before CDMUpdateDatabase function.

- int VIMGetNumProfiles()

- int VIMAddProfile(int id)

  This function is called to add a profile.

- int VIMDeleteProfile(int id)

  Returns number of active profiles.

- int VIMLoad(char fileName, int mode, int offset)

- int VIMCommit(char fileName, int mode, int offset)

- int VIMInit()

  The PIM interacts with

- VRM

- CDM

- PDM Thread

- EM

- CApp

- IO Manager

VIM - VRM

Both of these modules share view record database. This database is not processed, which means, operations such as, dividing a viewing record into two or more viewing records if it spans across multiple programs, are not performed. VIM uses this database to compute current profile mix.

For every viewing record VRM stores current profile mix. VRM uses VIMGetProfileMix() function to get the current profile mix.

The viewing record may be updated with the current profile mix as soon as the VRM creates a viewing record, or optionally the VIM may put the viewing mix in VIMComputeProfileMix, in which case all the explicit login/logout must be stored.

The VRM informs the VIM about various MbTV events. VIMComputeClusters function calls the VRM to get competing programs.

VIM-CDM

The CDM calls VIMGetProfileMix from CDMGetBestProgram function. The CDM builds a list of MbTV picks based on the current profile mix. The CDM also uses the profile mix value to update the CDM database.

VIM-PDM Thread

The PDM thread calls VIMComputeProfileMix() and VIMComputeClusters() periodically.

VIM-EM

The VIMComputeClusters function calls the EM functions to get program information.

VIM-CApp

CApp calls the VIMProfileLogin and VIMProfileLogout functions. It also calls the VIMAddProfile and VIMDeleteProfile functions.

VIM-IO Manager

IO Manager calls the VIMCommit and VIMLoad functions.

The interface specifications for the preferred embodiment of the PIM are described below.

Declared in custom.h.

```
#define MAX_PROFILE_NAME_LEN  40;
```

Declared in <include/pim_p.h>

```
#define MAX_PROFILE_COUNT       6;
#define PROFILE_DISABLED        0x01
#define PROFILE_FROZEN          0x02
typedef struct _profile_
{
    ulong           id;
    int         probability;
    ulong           status;
    char        name[MAX_PROFILE_NAME_LEN];
} profile_t, *pprofile_t;
typedef struct _prob_
{
    ulong           profileId;
    int         probability;
} prob_t, *pprob_t;
#define MBTV_NO_SUCH_PROFILE        1
#define MBTV_PROFILE_MAX_REACHED    2
```

Declared in pim.h

```
typedef struct _PIMEventRec_
{
    uchar           type;
```

```
    ushort          timeDiff;
    union           _param1_
    {
        void*           channelID;
        time_t          time;
        ulong           profileID;
        int         probability;
    } param1;
} PIMEventRec, *pPIMEventRec;
/* Events stored in PIM event list */
#define PIM_CHANNEL_CHANGE          1
#define PIM_TV_ON                   2
#define PIM_TV_OFF              3
#define PIM_TIME_EPOCH              4
#define PIM_PAUSE                   5
#define PIM_RECORD              6
#define PIM_STOP                    7
#define PIM_LOGIN                   8
#define PIM_LOGOUT              9
#define PIM_PROFILE_MIX         10
#define PIM_EVENT_EXTENSION         11
#define MAX_PREDICTED_ITEMS     20;
#define MBTV_INVALID_PROFILE_ID     MAX_PROFILE_COUNT
        Declared in pim.c
    /* Max allocation for PimEventList is
PimEventList[MAX_EVENT_COUNT];
PIMEventRec     *PimEventList;
    /* Number of events available in PimEventList. */
int         PimEventCount;
    /* Allocation for PredictedExpectation is
    PredictedExpectation[MAX_PROFILE_COUNT][MAX_PREDICTED_IT
EMS];
```

```
        */
float           **PredictedExpectations;
    /* Allocation for Variations is
    Variations[MAX_PROFILE_COUNT];
    */
float           *Variations;
    /* Allocation for ViewingMixture is
    ViewingMixture[MAX_PROFILE_COUNT];
    */
float           *ViewingMixture;
profile_t *profiles;
int             *profileActive;
```

Name

PIMGetNumProfiles

Synopsis

#include <include/pim_p.h>

int

PIMGetNumProfiles(int   *cntProfiles)

Description

The input parameter cntProfiles is used to return the number

of profiles currently available.

Return value

On success, returns 0.

Name

PIMGetProfileID

Synopsis

#include <include/pim_p.h>

int

PIMGetProfileID(int profileNum, ulong *profileID)

Description

This function is called to get profile ID. Input to this

function is an integer parameter, profileNum, set between 0

and (N −1) where N is the return value of PIMGetNumProfiles. The associated profile ID is returned in the parameter profileID.

Return value

On success, returns 0.

Error

Returns MBTV_NO_SUCH_PROFILE if there is no profile id associated to profileNum.

Name

PIMGetProfileNumber

Synopsis

#include <include/pim_p.h>

int

PIMGetProfileNumber(ulong profileID, int *profileNum)

Description

This function provides the reverse functionality of the PIMGetProfileID functions and gives the mapping from the profile id specified by profileID to the profile number.

Return value

On Success, returns 0.

Error

MBTV_NO_SUCH_PROFILE, if profileID is not valid.

Name

PIMAddProfile

Synopsis

#include <include/pdm.h>

int

PIMAddProfile(ulong *profileID)

Description

This function is used to create a new profile id with a set of predefined defaults. The maximum number of profiles that

can be created is implementation specific and is set to some
predefined upper limit.

Return value

0 if success. Non-zero otherwise. On success the input
parameter profileID is set to the profile id of the newly
created profile.

Error

Returns MBTV_PROFILE_MAX_REACHED if maximum number of
profiles has been reached.

Name

PIMDeleteProfile

Synopsis

#include <include/pdm.h>

int

PIMDeleteProfile(ulong profileID)

Description

This function deletes the profile specified by input
parameter profileID.

Return value

Returns 0 on success, non-zero otherwise.

Error

Returns MBTV_NO_SUCH_PROFILE if no profile is associated to
profileID.

Name

PIMGetProfileParams

Synopsis

#include <include/pdm.h>

int

PIMGetProfileParams(ulong profileID, profile_t *pprofile)

Description

This function copies the profile_t structure associated with
the profile *profileID* into the profile_t structure pointed to

by pprofile. pprofile points to an area allocated in the
caller space.

Return value

Return 0 on success, non-zero otherwise.

Error

Returns MBTV_NO_SUCH_PROFILE if there is no profile
associated to profileID.

Name

PIMSetProfileParams

Synopsis

#include <include/pdm.h>

int

PIMSetProfileParams(ulong profileID, profile_t *pprofile)

Description

This function sets the profile parameters associated with the
profileID as per the profile data in the profile_t structure
pointed to by pprofile. pprofile points to an area allocated
in the caller space. The caller cannot change profile id
using this function.

Return value

Return 0 on success, non-zero otherwise.

Error

Returns MBTV_NO_SUCH_PROFILE if there is no profile
associated to the profileID.

Name

PIMGetCurrentProfile

Synopsis

#include <include/pdm.h>

int

PIMGetCurrentProfile(ulong numProfiles, prob_t
*profileProbability)

Description

This function returns information on which of the specified profiles are currently engaged in watching TV. The profiles of interest are passed in the *profileID* field of prob_t structures pointed to by profileProbability. If the profileID field is set to MBTV_INVALID_PROFILE_ID, information is passed for first numProfiles profiles supported by the PDM and the profileID field is set to accordingly. The probability field is set to the probability of the profile being currently engaged in watching TV. A probability value of 100 indicates an explicitly logged in profile. A probability value above a predetermined threshold may be considered as a completely recognized profile.

Return value

Return 0 on success. If profileID is set to MBTV_INVALID_PROFILE_ID at input, it is set to proper values if the function call succeeds. If for any porfileID there exists no associated profile then that profileID is set to MBTV_INVALID_PROFILE_ID.

Error

Returns MBTV_NO_SUCH_PROFILE if for any of the profileID values, there is no associated profile.

Name

PIMNotify

Synopsis

#include <src/pdm/inc/pim.h>

int

PIMNotify(cBackInfo_t *pcBackInfo, time_t epgTime)

Description

PIMNotify should be called whenever MbTVCallback function is called. pcBackInfo points to a structure of type cBackInfo allocated by the caller. This function does not modify the structure.

Return value

Always 0

Error

None.

Name

PIMLoginProfile

Synopsis

#include <src/pdm/inc/pim.h>

int

PIMLoginProfile(ulong profileID)

Description

PIMLoginProfile is called to explicitly inform the presence
of a profile in a TV viewing session.

Return values

0 if no error, non-zero value error value otherwise.

Errors

MBTV_NO_SUCH_PROFILE if profile for the given profileID does
not exist.

Name

PIMLogoutProfile

Synopsis

#include <src/pdm/inc/pim.h>

int

PIMLoginProfile(ulong profileID)

Description

PIMLogoutProfile is called to explicitly logout the profile
specified by profileID.

Return values

0 if no error, non-zero value error value otherwise.

Errors

MBTV_NO_SUCH_PROFILE if profile for the given profileID does
not exist.

Name

PIMComputeProfileMix

Synopsis

#include <include/pdm.h>

#include <src/pdm/inc/pim.h>

int

PIMComputeProfileMix()

Description

PIMComputeProfileMix is called by PDM housekeeping thread. It computes current profile mix. It should be called periodically.

Return value

Return 0 if successful, non-zero otherwise.

Name

PIMComputeProfiles

Synopsis

#include <include/pdm.h>

#include <src/pdm/inc/pim.h>

int

PIMComputeProfiles()

Description

PIMComputeProfiles is called by PDM housekeeping thread. It computes and updated profiles. It should be called periodically. This function should be called before updating CDM database.

Return value

Return 0 if successful, non-zero otherwise.

Name

PIMLoad

Synopsis

#include <include/pdm.h>

#include <src/pdm/inc/pim.h>

int

PIMLoad(char *fileName, int mode, int offset)

Description

IO manager calls this function to load PIM related data from a file. PIMLoad reads data into the following data structures.

- *PimEventList*

- *PredictedExpectations*

- *Variations*

- *profiles*

- *ViewingMixture*

Return value

Returns number of bytes read by this function if successful. Negative value in case of an error.

Name

PIMCommit

Synopsis

#include <include/pdm.h>

#include <src/pdm/inc/pim.h>

int

PIMCommit(char *fileName, int mode, int offset)

Description

IO manager calls this function to save PIM related data into a file. PIMCommit writes following data structured into a file.

- *PimEventList*

- *PredictedExpectations*

- *Variations*

- *profiles*

- *ViewingMixture*

Return value

Returns number of bytes written by this function if successful, or a negative value in case of an error.

<u>Viewer Record Manager</u>

The interface specifications of the preferred embodiment of the VRM are described below.

Declared in <include/pim_p.h>

#define MAX_PROFILE_COUNT   6;

Declared in <include/common_p.h>

```
/* VRM states */
#define MBTV_POWER_ON                1
#define MBTV_POWER_STANDBY           2
#define MBTV_REWIND                  3
#define MBTV_FAST_FORWARD            4
#define MBTV_PAUSE                   5
#define MBTV_RESUME                  6
#define MBTV_PLAY                    7
#define MBTV_RECORD                  8
#define MBTV_STOP                    9
#define MBTV_JUMP_TO_LIVE            10
#define MBTV_CHANNEL_CHANGE          11
#define MBTV_LINEUP_CHANGE           12
#define MBTV_END_CHANNEL             13
#define MBTV_SKIP_BACKWARD           14
#define MBTV_SKIP_FORWARD            15
typedef struct _cBackInfo_
{
    int                     currEventType;
    int                     prevEventType;
    time_t                  eventTime;
    time_t                  eventDuration;
    void*                   channelID;
    int                     channelType;
```

```
        int                         errorNum;
        int                         reserved;
} cBackInfo_t, *pcBackInfo_t;
        Declared in config.h
#define BINARY_FORMAT        2
#define ASCII_FORMAT         1
        Declared in <include/vrm.h>
#define PGM_JUMP_MAX_TIME         120  /* 120 minutes of
*/
/*  jumping off and on       */
#define PGM_WATCH_TRESHOLD    1       /* 5 minutes treshold
*/
/* to create viewer record  */
#define PGM_SCAN_TRESHOLD        7       /* 7 seconds to
treshold      */
typedef struct
{
    void    *channelID;
    time_t  viewingTime;
    time_t  epgTime;
    ushort  viewingDuration;
    uchar   channelType;
#ifdef __VIM__
#define MAX_PROFILE_NUM      MAX_PROFILE_COUNT
    uchar   probability[MAX_PROFILE_NUM];
#endif
} viewRec_t;
        Declared in vrm.c
/* max allocation for viewer record database (implementation
dependent) */
#define VIEWER_MAX_SIZE      (1024 * sizeof(viewRec_t))
```

Public Interface Functions

Declared in names_p.h

#define MbTVCallBack   VMCallBack

Declared in vrm_p.h

*int   VMCallBack(cBackInfo_t *cBInfo);*

Internal Interface Functions

Declared in vrm.h

int   VMInit(void);

*int   VMCommit(char *fName, int offset, int mode);*

*int   VMLoad(char *fName, int offset, int size, int mode);*

*viewRec_t *VMGetNextViewingRec(viewRec_t *ptr, time_t start);*

int   VMProcessViewingRec(time_t start, time_t end);

int   VMDeleteViewingRec(time_t till);

Name

VMInit

Synopsis

#include <pdm/inc/vrm.h>

int VMInit(void)

Description

Initialises VRM by allocating memory for all internal objects and assigning default values to all global variables,

Return value

On success, returns 0.

Name

VMCommit

Synopsis

#include <pdm/inc/vrm.h>

int VMCommit(char *fName, int offset, int mode);

Description

This function stores all VRM inetrnal objects and states into the file given by fName argument at the offset given by offset argument. The argument mode is used to specify either

binary or asci mode of data representation on the file. It
can be respectively BINARY_FORMAT or ASCII_FORMAT.
Return value
On success, returns 0.

Name
VMLoad
Synopsis
#include <pdm/inc/vrm.h>
int VMLoad(char *fName, int offset, int size, int mode);
Description
This function restores all VRM inetrnal objects and states
from the file given by fName argument at the offset given by
offset argument. The argument mode is used to specify either
binary or asci mode of data representation on the file. It
can be respectively BINARY_FORMAT or ASCII_FORMAT.
Return value
On Success, returns 0.
Name
VMGetNextViewingRec
Synopsis
#include <pdm/inc/vrm.h>
viewRec_t *VMGetNextViewingRec(viewRec_t *ptr, time_t start)
Description
This function gets viewer records from database. Fist time it
is called With NULL value of the ptr argument. It returns
pointer to the first available viewer record since the time
which is given by start argument.
If the value of start argument is (time_t)0 the function
returns the first record in the current viewing session. In
all subsequent calls the argument ptr is to be used as
positional context for the next viewer record.

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The argument start is used to get viewer record starting from
this particular time. If viewer record has a viewingTime
value less then a value of the start argument and a
viewingDuration + viewingTime is greater then this value such
viewer record will be skipped.

Before call to VMGetNextViewingRec() be sure to call
VMProcessViewingRec() to prepare viewer records for the given
period of time.

Return value

On success: a pointer to the next viewer record,
otherwise (no more viewer records) NULL.

Name

VMProcessViewingRec

Synopsis

#include <pdm/inc/vrm.h>

int VMProcessViewingRec(time_t start, time_t end);

Description

VMProcessViewingRec() generates viewer record starting from
given start time value till end. It fills in all fields of
viewRec_t structure what is not possible during viewing
record creation. It calls EPG library functions and TSM
module functions to obtain all information needed for viewer
record.

Viewer records originally are created by VMCallback()
function and keep information on when and on which channel
it has been done.

VMProcessViewingRec() function may divide original record
into several different ones accordingly to how many programs
were available during the period described by the
viewingDuration field of the viewer record.

Return value

Returns 0 on success, non-zero otherwise.

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Name

VMDeleteViewingRec

Synopsis

#include <pdm/inc/vrm.h>

int VMDeleteViewingRec(time_t till);

Description

VMDeleteViewingRec() deletes all viewer records since start
of the current viewing session and until the time specified
by the till argument. It also unlocks virtual channel data in
SDM for each deleted record corresponding to that virtual
channel.

Return value

Return 0 on success, non-zero otherwise.

Name

VMCallBack

Synopsis

#include <pdm/inc/vrm_p.h>

void   VMCallBack(cBackInfo_t *cBInfo);

Description

    VMCallBack() supports communications between the VRM,
the Category Database Manager (CDM), the Profile
Identification Module (PIM) and the Storage and DVCR Manager
(SDM). VMCallBack() is called by the SDM every time any of
VRM events has come.

    The following is the set of VRM events.

#define MBTV_POWER_ON   1

#define MBTV_POWER_STANDBY   2

#define MBTV_REWIND   3

#define MBTV_FAST_FORWARD   4

#define MBTV_PAUSE   5

#define MBTV_RESUME   6

#define MBTV_PLAY   7

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```
#define MBTV_RECORD             8

#define MBTV_STOP               9

#define MBTV_JUMP_TO_LIVE       10

#define MBTV_CHANNEL_CHANGE     11

#define MBTV_LINEUP_CHANGE      12

#define MBTV_END_CHANNEL        13

#define MBTV_SKIP_BACKWARD      14

#define MBTV_SKIP_FORWARD       15

#define MBTV_ADD_CHANNEL        16

#define MBTV_DELETE_CHANNEL     17
```

In response to these events VMCallBack()

MBTV_POWER_ON, MBTV_POWER_STANDBY :

    creates or terminates a viewing session;

MBTV_CHANNEL_CHANGE, MBTV_POWER_STANDBY,

MBTV_PAUSE, MBTV_STOP, MBTV_END_CHANNEL :

    generates viewing records;

MBTV_ADD_CHANNEL, MBTV_DELETE_CHANNEL :

    add/delete premium channels to/from channel lineup.

    In addition, for every event it notifies the VIM by calling VIMNotify() function and for every viewer record generated it notifies the VIM by calling VIMGetProfileMix() function.

Viewer records are generated in the following way.

    If channel viewing duration is less than PGM_SCAN_TRESHOLD (7 seconds) then viewing record is not created. Otherwise it is created and goes into intermediate buffer. If it stays in this buffer longer than PGM_WATCH_TRESHOLD (5 minutes) it is processed to break it onto set of viewer records corresponding to all different programs watched during live time of the original record and then all of them which are longer than PGM_WATCH_TRESHOLD go into viewer record database.

If viewer record coresponds to a virtual channel its EPG data is locked in SDM by call to SDMLockChannelEPGData() made by the VRM.

Return value

None.

Categories Database Module

The viewer record generated by VRM gives information about events such as channel change, power on and power off. The CDM uses these viewer records to generate the Liking records. Liking records are used to monitor a set of EPG parameters of the programs derived from the viewer records. Of all the EPG parameters available for a program, only a few selected ones are relevant for generating CDB Liking records. Each liking record comprises of a set of EPG parameters. Information is also kept on the cumulative viewing duration of the set of parameters and the cumulative duration for which it was available for viewing. For storing the EPG parameters in the liking record, the CDB first inserts the EPG parameter strings in the String Table and uses the index (returned by the String table) in place of the actual parameter string.

Functional Design Description

The CDM functions can be classified into

- Creation and updating of *Liking records*. The array of *Liking records* is also called the *Category Database*. This is described in the following section.

- Computation of MbTV picks or MbTV top 10 and Program Ratings from the data in *Category Database*. This is described in the document-titled cdb.txt.

The VRM maintains a list of viewer actions as viewer records. The CDM uses these viewer records to create liking records.

The PDM background thread calls the CDMUpdateDatabase function. The CDMUpdateDatabase is achieved in 2 passes.

Pass - 1: It reads viewing records from VRM. CDM uses information stored in a viewing record to get program information from Internal EPG (IEPG). It creates a set of index (these indexes are created when the EPG parameter string is entered in the String table) using the program information. This set of index forms a part of *Liking record*. It there exists no liking record with the given set of index, CDM creates one such record and puts it into *Liking Record Database. Liking records* created are of type self-learnt or user-prompted. There are some cases, such as *Pay Per View* channels, where some special handling is done. When inserting a new liking record the CDB scans for existing liking records for which some of the EPG parameter's values are the same. For each such matching record, a new liking record is created which consists of the only the matched parameter values.

Consider the following example. Let the EPG parameters being monitored be the Channel Parameter, Program Type & Title. Let one of the existing liking records comprise of the parameter values of (CNN, News, Evening News) respectively. Let the new record to be inserted comprise of the parameter values of (FOX NEWS, News, Fox News) respectively. When insert the above record, an additional record is also inserted which comprises of (DC, News, DC). Here DC refers to a predefined value (to signify a Don't Care condition) which would be considered a match with all parameter values that it is compared with. For example liking records comprising of (CNN, News, Evening News) and (DC, News, Evening News) are considered to be completely matched.

Pass - 2 : It updates the time watched and the time available fields for all matched the liking records. For a

program viewed by the viewer, value of *time watched* and *time available* is computed using the viewing record and the liking records of all the matched records are updated. For all other programs that were available at the same time the *time available* field is updated for all the matching records. The watched/available value correlates to the viewer's interest and is the basis for future computations for program preference.

Consider the liking records given in the table below. Keys used in the table are given below.

Table Keys

Recordno –	RNO
ProgramType –	PTY
Channel –	CHN
Category –	CTG
Stars –	STR
Affiliation –	AFF
ProgramTitle –	PTT
TimeWatched –	TWP(x)
TimeAvailable-	TAP(x)
RecordCount.-	RCN
Episode –	EPI
Comedy	COM

Note in the above field acronyms since there are multiple profiles TimeWatched and TimeAvailable take on multiple values. Thus TimeWatched – TWP(x) means TimeWatchedProfile(1), TimeWatchedProfile(2) etc. Similarly for TimeAvailable.

RNO	PTY	CHN	CTG	STR	AFF	PTT	TWP (1)	TAP (1)	TWP (2)	TAP (2)	RCN
1	EPI	ABC	COM	DC	DC	0	0	0	0	0	0
2	EPI	TNN	COM	DC	DC	Kids in the	30	60	15	15	1

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						Hall					
3	EPI	TNN	Music	Care y	0	DC	0	0	15	15	1
4	EPI	TNN	Action	Chan	0	Bronx Rumbles	60	60	15	15	1
5	EPI	TNN	COM	Jane	0	For your love	20	20	0	0	1
6	EPI	ABC	Music	DC	0	DC	15	45	0	0	1
7	EPI	ABC	Music	DC	DC	DC	10	60	45	45	1
8	EPI	DC	News	0	0	DC	15	15	15	45	1
9	EPI	CNN	News	0	0	Evening News	0	0	30	30	1
10	EPI	FOXNews	News	0	0	Fox News	0	60	0	0	1

Let the viewing record specify a viewing duration of 15 minutes for the program comprising of EPG parameters (CNN, News, Evening News). Let the set of programs available at that time be programs comprising of the EPG parameters (FOXNews, News, FoxNews) and (CNN, News, Evening News). The liking records updated for both watched & available values are record numbers 9 & 8. The liking records updated for available values only records 10 & 8.

Data Structures

The main data structures used by the CDM are:

1.   The viewRec_t structure. (described in the document VRM.doc)

2.   The likingRecord structure

3.   The ProgramInfo structure (described in the PDM I/F document)

The likingRecord structure is as follows:

```
typedef _likingRecord_          likingRecord, *plikingRecord;
struct _likingRecord_
{
        ushort          index[INDEX_COUNT];
        uint        watched[MAX_PROFILE_COUNT];
        uint        available[MAX_PROFILE_COUNT];
```

```
ushort              recordCount[MAX_PROFILE_COUNT];
```
/* Assuming maximum 16 profiles. Each profile will use
one bit from   recordCountUpdated variable */
```
ushort              recordCountUpdated;
};
```

In the liking record structure:

Index: This is an array of parameters that relate to
                program watched. The parameters themselves
                can be "Program Name", "Program Title",
                "Program Category" etc.

Watched: This gives the duration of time for which the
                program was watched.

Available: This gives the duration of time for which the
                program was available.

RecordCount: This is incremented as and when the similar
                type of liking record is generated. It is
                mainly used as a reference count.

RecordCountUpdated: This is used to identify the profile
                under which the record count was updated.

The interface specifications of the preferred embodiment
of the VRM are described below.

The Implicit Filters

The interface functions that are available for implicit
filters are:

Name

SDMGetNumImplicitFilters - Returns the number of Implicit
filters that are available for use.

Synopsis

#include "src/sdm/inc/sdm.h"

int SDMGetNumImplicitFilters(int *fltCnt)

Description

This function returns the number of implicit filters
supported. This is known at compile time itself by a #define.
Return Value
On success, zero is returned. On error a non-zero is
returned.

Name

SDMGetImplicitFilterID - Returns the ids of Implicit filters
that are available for use.
Synopsis
#include "src/sdm/inc/sdm.h"
int SDMGetImplicitFilterID(int filterNum,void **filterID);
Description
This function returns the ids of implicit filters supported.
These ids are known at compile time itself by a #define. The
id for the implicit filters is always some number other than
those assigned to the explicit filters.
Return Value
On success , zero is returned. On error a non-zero is
returned

Name

GetMaxFilters - Returns the max number of filters that are
permitted.
Synopsis
#include "src/sdm/inc/sdm.h"
int getMaxFilters(int filterFlag);
Description
This function takes as argument an integer which denotes
whether it is for explicit filters OR implicit filters and
returns the maximum number of filters that are permitted for
each category.
Return Value

On success , the max number is returned .On error a negative-
number is returned.

CDM Updating

Name

CDMUpdateDatabase - Updates the Category database up to a
given endtime.

Synopsis

#include "src/pdm/inc/cdm.h"

int CDMUpdateDatabase(time_t endTime);

Description

This function updates the Category Database Manager with the
available viewer records up to a given time period.

Return Value

On success, zero is returned. On error a non-zero is
returned.

Deactivation filters

The following data structure is used for Learning
deactivation.

Struct dfilter_t

{

    ulong id;

    void * chnlID;

    int   deactivateStart;

    int   deactivateEnd;

}

The CDM supports the following functions for Learning
Deactivation:

Name

CDMCreateDFilter - To create a new Deactivation Filter.

Synopsis

#include "src/pdm/inc/cdm.h"

int CDMCreateDFilter(ulong *dfilterID);

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Description

This function creates the new learning deactivation filter
with an id value

0 < id < MAX_DFILTER_ID

Return Value

On success , zero is returned. On error a non-zero is
returned.

Name

CDMDeleteDFilter – To delete a Deactivation Filter.

Synopsis

#include "src/pdm/inc/cdm.h"

int CDMDeleteDFilter(ulong *dfilterID);

Description

This function deletes deactivation filter with the specified
id.

Return Value

On success , zero is returned. On error a non-zero is
returned.

Name

CDMGetDFilter – Returns the learning deactivation filter
information for the specified id.

Synopsis

#include "src/pdm/inc/cdm.h"

int CDMGetDFilter(ulong dfilterID,dfilter_t *pdFilter);

Description

This function fills in the dfilter_t structure with
information when it is called with a specific id, and
preallocated dfilter_t structure.

Return Value

On success , zero is returned. On error a non-zero is
returned.

Name

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CDMSetDFilter – The learning deactivation filter information for the specified id is updated using this function

Synopsis

#include "src/pdm/inc/cdm.h"

int CDMSetDFilter(ulong dfilterID,dfilter_t *pdFilter);

Description

This function updates the dfilter_t structure with information when it is called with a specific id.

Return Value

On success , zero is returned. On error a non-zero is returned.

PDM Operation

Figures 48 and 49 depict the data flow stream of the various modules of the PDM and their interaction with the other elements comprising the overall system within which the present invention is preferably intended to function. The following sections present examples of the type of data generated by the various modules as part of the preference determination process.

CLICK STREAM DATA

Generated by the VRM foreground module.

As the user operates the Television, or displayed STB, events such as channel change and power off are saved in the Click Stream data storage, see example in table n9x.

The actual value stored is a Unique Identifier (EPG-UID), fetched via the CAPP from the EPG Library module, and originally generated by the native EPG system for the channel. This can be cross-referenced back to the actual tuning details and channel name by the EPG Library module at a later time as required. For the case of Power-Off the MBTV software generates another Unique ID value.

The probability columns are added after computation by the PIM to predict which profile (cluster) or viewer or viewing group is watching now based on past viewing, see PIM data and profiles data later.

Click Stream Data Store Example

Event number	Channel Change ID Event or Power Event	TIME	Profile 1 Probability	Profile 2 Probability	Profile n Probability
1	EPG-UID Channel 1	6:00:00	0.1	0.9	0
2	EPG-UID Channel 2	6:10:00	0.4	0.6	0
3	EPG-UID Channel 1	6:15:00	0.2	0.8	0
4	EPG-UID Channel 2	6:25:00	0.3	0.7	0
5	UID for Power Off	6:35:00			
6					

VIEWER RECORD DATA

Generated by the VRM background module.

The number of records of the Click Stream data is expanded to also include program change events, see 6:30 in the example in table n9x. So a 'lack of action' taken by a viewer as a program changes is compensated for by adding the Program change events and saving the new data in the Viewer Record Data store.

The probability columns are copied down from the click stream data.

Viewer Record Data Store Example

Event number	Enhanced Channel Change ID Event or Power Event	TIME	Profile 2 Probability	Profile 2 Probability	Profile n Probability
1	EPG-UID Channel 1	6:00:00	0.1	0.9	0
2	EPG-UID Channel 2	6:10:00	0.4	0.6	0
3	EPG-UID Channel 1	6:15:00	0.2	0.8	0
4	EPG-UID Channel 2	6:25:00	0.3	0.7	0

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5	EPG-UID Channel 2	6:30:00	0.3	0.7	0
6	UID for Power Off	6:35:00			
7					

VIEWER HISTORY DATA

Generated by the VHM background module.

This time information is saved about which programs have been viewed (not channels this time). This is for use by modules that use the Preference Database, eg the Storage Module (SDM), where there is only a need to know which programs have been watched.

Three items are used by the VHM software module to make a unique 4 byte Program ID value called PGM-UID which is saved in the store. The three items are as follows:

(1)   Program Title

(2)   Program Sub-Ttitle

(3)   Episode Title.

The PGM-UID, once generated, cannot be reverse processed back to the original information. As a point of information, this is text rather than knowledge based. So for example spelling mistakes in any of the original three items are unavoidably processed to give the appearance of a different program.

Viewer History Data Store Example

Event number	Program Viewed MBTV ID Event
1	PGM-UID
2	PGM-UID
3	PGM-UID
4	

PIM EVENT LIST DATA

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This is a collection of click stream data but contains the Event type eg Channel Change is an event type, Login is an event type and also Power On or Power Off. Also included is the time of the Event and any necessary parameters. The stored TYPE value is an MBTV defined constant number. This number can be cross-referenced to the description of the event.

Relevant parameters are the EPG-UID (Channel Unique ID) for the Channel Change Event. For the Login event type the parameter is an MBTV derived number.

PIM Event List Example

Event number	Event -TYPE of Event	TIME	Related PARAMETER
1	CHANNEL CHANGE	6:00:00	Channel (EPG-UID) 1
2	CHANNEL CHANGE	6:10:00	Channel (EPG-UID) 2
3	CHANNEL CHANGE	6:15:00	Channel (EPG-UID) 1
4	CHANNEL CHANGE	6:25:00	Channel (EPG-UID) 2
5	POWER OFF	6:35:00	None
6	PROFILE LOGIN	6:45:00	Profile (MBTV number)

The information in the above table is used to derive the profile or cluster data.

PROFILE DATA (also called CLUSTER DATA)

The default set-up is for 3 of these Profile data sets (ie 3 tables) though this may be changed by user intervention. Single or group viewing data is sorted in to Profiles sometimes called Clusters. The PIM software examines the PIM Event list table. Channel change events are copied in

to each profile and values set. Based on viewing statistics collected over a time the Average Liking and Deviation is calculated by MBTV software using the 'EM Algorithm' for clustering which is referenced.

The lower the actual value for Average Liking the less the channel is favored by the particular profile. The values are used periodically to compute which profile is viewing at that time. That is a probability number attached to the Click Stream Data. So the guess about which profile is viewing at this time is based on past history.

PIM Profile (Cluster) Example of one of the 3.

Entry number	Channel ID	Average (Liking)	Deviation
1	EPG-UID	0.008	0.0002
2	EPG-UID	0.01	0.0004
3	EPG-UID	0.02	0.0006
4	EPG-UID	0.008	0.0002
5			

Back-Up IO Manager Module

The I/O Manager is the module which will interacts with all other modules in PDM and SDM for the storage and retrieval of data i,e backup and loading of all the data from these modules. Following are the list of the modules and also the sub modules present in the system with which IO Manager interacts.

● PDM

        String Table (ST)

        Category Database (CDB)

        Viewer Record Module (VRM)

        Internal EPG (IEPG)

        Viewer History Module (VHM)

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● SDM

Storage and Retrieval

>Data from the each module is stored in a separate
>files which will have the prefix which is read from
>the customs.h or from the read from the config file
>and the undersigned module name with that. For
>example if we are having the prefix as Mbtv in
>config file then we will have the following files
>created by the IO Manager
>
>Mbtv_cdb
>
>Mbtv_st
>
>Mbtv_vrm
>
>Mbtv_vhm
>
>Mbtv_pim
>
>Mbtv_iepg
>
>Mbtv_sdm

The different functions that are supported by the IO
Manager are as follows:

1. IOLoad(void);
   Description: This function loads the all the data for
   the PDM and SDM by calling the appropriate Load
   functions that are present in the different modules.
   Returns: Returns 0 upon success and non zero value if
   any error occurs.
   The data for the different modules are loaded in the
   following sequence.
   STLoad(char fileName, int offset,int mode);
   /*   String Table Load */
   CDMLoad(char fileName, int offset,int mode);
   /* Category Database Load */
   VMLoad(char fileName, int offset,int mode);
   /* Viewer Record Load   */
   EMLoad(char fileName, int offset,int mode);
   /* Internal EPG Load */
   VHMLoad(char fileName, int offset,int mode)
   /* Viewers History Load */
   PIMLoad(char fileName, int offset,int mode)
   /* PIM Load */

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```
        SDMLoad(char fileName, int offset,int mode);
        /* SDM Load */
2. IOCommit(void);
        Description:   This function commits the all the data
        for the PDM and SDM by calling the appropriate commit
        functions that are present in the different modules. The
        setIOState () function is called before calling this
        function which will set the flag, which in turn
        indicates the module data to be committed.
        Returns:  Returns 0 upon success and non-zero value if
        any error occurs.
3. setIOState(int. flag);
        Description:   This function is used for setting the
        value for the flag variable, which will indicate module
        to be committed.
        Returns:  Returns 0 upon success and non-zero value if
        any error occurs.
        Following are the different flag values that are passed
        to the setIOState function.
        # define ST_COMMIT        0x8000
        # define CDM_COMMIT       0x4000
        # define VRM_COMMIT       0x2000
        # define PIM_COMMIT       0x1000
        # define VHM_COMIMIT      0x0800
        # define EM_COMMIT        0x0400
        # define SDM_COMMIT       0x0200
        # define ALL_COMMIT       0x0100
   When the flag is set to ALL_COMMIT the following commit
   functions that are available in the different modules are
   called.
   CDMCommit(char fileName,int offset,int mode); /* Category
        Database Commit*/
   STCommit(char fileName,int offset, int mode);    /*  String
        Table Commit */
   VMCommit(char fileName, int offset, int mode); /* Viewer
        Record Commit   */
   EMCommit(char fileName, int offset, int mode);  /* Internal
        EPG Commit */
   VHMCommit(char fileName, int offset, int mode) /* Viewers
        History Commit */
   PIMCommit(char fileName, int offset, int mode)  /* PIM
        Commit  */
   SDMCommit(char fileName, int offset, int mode); /* SDM
        Commit */
4. int getIOState(int *flag);
        Description:   This function is used for reading the
        value of flag variable, which is set by using the
        setIOState function.
```

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Returns: Returns 0 upon success and non-zero value if any error occurs.

5. int clearIOState(int flag);

Description: This function is used for resetting the value of flag variable, which is set by using the setIOState function.

Returns: Returns 0 upon success and non-zero value if any error occurs.

CDB File Format

- File Header

```
struct CDMFileHeader
{
        char            name[128];
        float            version;
        long            time;
        int              indexCount;
        int              nonWildIndexCount;
};
```

- Data from the CDB:-

```
struct _likingRecord_
{
    unsigned short      index[INDEX_COUNT];
    unsigned int        watched[MAX_PROFILE_COUNT];
    unsigned int        available[MAX_PROFILE_COUNT];
    unsigned long       recordCount[MAX_PROFILE_COUNT];
    unsigned short   recordCountUpdated;
};
```

VRM File Format:

- File Header

```
struct VRMFileHeader
{
        char            name[128];
        float            version;
        long            time;
        int.            Number of records.
   int.          Size.
};
```

- Data

```
typedef struct
{
    char  *data;    /* pointer to data */
    uint  size;       /* memory image size in bytes */
    uint  maxSize;
    uint  alive;      /* position in the viewer
database of the first alive record */
    short del;        /* number of deleted records */
} viewer_t;
```

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```
typedef struct
{
    void    *channelID;
    time_t  viewingTime;
    time_t  epgTime;
    ushort  viewingDuration;
    uchar   channelType;
#ifdef __VIM__
#define MAX_PROFILE_NUM     MAX_PROFILE_COUNT
    uchar   probability[MAX_PROFILE_NUM];
#endif
} viewRec_t;
```

While Storing in ASCII
- One record per one line
- ChannelID is replaced by Channel Name

IEPG File Format
- File Header

```
struct IEPGFileHeader
{
        char            name[128];
        float            version;
        long            time;
        int.            Number of records.
int.            Size.
};
```

- Data

```
typedef struct {
    time_t      pgmStartTime;
    ushort      pgmDuration;
    uint        mask :24;           /* 24
possible available Mbtv pointers */
    uint        len  :8;                /* total
record length */
    mbtv_t      ptrs[24];
} epgRec_t;
  typedef struct {
    uint    size;                   /* memory image
size in bytes */
    uint    maxSize;        /* max size of the
image */
    ushort del;                 /* number of
deleted records */
    char    *data;              /* pointer to data
*/
  } epgDb_t;
```

ST File Format:
- Table Header
```

```
        ulong       delList;                /* offset of
the list of */
                                                        /*
deleted strings */
        ulong       size;               /* offset of free
space */
        ulong       maxSize;                /* maximum
table size */
        ulong       strNum;                 /* string
number */
        ulong       maxStrNum;      /* maximum string
number */
```

- Data

        String Table Data.

    Note :

        String table is not stored in ASCII mode.
        <u>VHM File Format</u>

- File Header

```
        struct VHMFileHeader
        {
            int         idCount;
            int         sortedListIDCount;
            int         historyListSize;
            float       version;
        };
```

- Data

            Array of Ulong
        <u>PIM File Format</u>

- File Header

```
        struct PIMFileHeader
        {
                char            name[128];
                float            version;
                long            time;
                int.            Number of records.
    int.            Size.
        };
```

- Data
  1. PIM Event List

```
        PIMEventRec *PimEventList;

  typedef struct  PIMEventRec
  {
    uchar type;
    ushort timediff;
    union param1
    {
        void* channelID;
```

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```
            time_t time;
            ulong  profileID;
            int  probablity;
        }param1;
        } profile_t;
2. Predicted Expectations
        float **PredictedExpecttations;
3. Variations
        float *Variations;
4. Profiles
        typedef struct  profile_ {
        ulong id;
        int  probablity;
        ulong status;
        char name[MAX_PROFILE_NAME_LEN];
        } profile_t;
5. Viewing Mixture
        float  *ViewingMixture;


            SDM File Format

•  File Header

                struct SDMFileHeader
                {
                    char          name[128];
                    float          version;
                    long          time;
                };
•  Data

        -Virtual Channel Count
        -Virtual Channel Data
                struct _channel_info_
                {
                    void          *chID;
                    char          chName[CH_NAME_SIZE];
                    void          *chData;
                    char          prm1[20];
                    char          prm2[20];
                };
        -No of Filters
        -Filter Data
        typedef struct _filter_
        {
            ulong    filterID;
            int       userID;
            ulong    filterTypeID;
```

```
        char
filterString[MAX_NUM_PARAMS][MAX_PARAM_LEN];
        int             currAllocation;
        int             maxAllocation;
        int             desiredAllocation;
} filter_t, *pfilter_t;
-Current State of SDM
```

Config File Manager

Config File manager is the module, which is used to read the different values from the configuration file for the particular tag value. The different interface functions that are present in the config file manager are as follows.

1. int readconfig(char *filename,char *token,char *buffer,int *len);

    Description: This function is called for reading the value of the tokens from the text file. The first argument for the function is the filename from which the token has to be read ,second argument is the name of the token whose values are going to be read, third argument is the buffer to which the token values are copied and the fourth argument is the length of the buffer.

    Returns: Returns 0 upon success and non-zero value if any error occurs.

    Calls :   int fileinit(char[],char[]);

           int readtockens(char*,int,char*,int*);

2. FILE* fileinit(char *filename,char *mode);

    Description: This function open the file mentioned in the first argument with the mode mentioned in the second argument.

    Returns: Returns FileHandle upon success and NULL if any error occurs.

3. int readtockens(char *tag,int fp,char *buffer,int *len);

    Description: This function will read the token values for the tag present in the first argument from the file

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fp and stores in the buffer with a separator "@" and the length of the buffer is stored in len.

Returns: Returns 0 upon success and non-zero value if any error occurs.

Config File Format :-

[Tag _BEGIN]   ←   Specifies the tokens whose values have to read.

Value

Value

Value

[Tag_End]

Sample Config File With the above Format :-

    MBTV_CONFIG_FILE_NAME_BEGIN

    Mymbtv.txt

    MBTV_CONFIG_FILE_NAME_END

    MBTV_IO_PREFIX _BEGIN

    Mbtv

    Mbnw

    IOFile

    MBTV_IO_PREFIX _END

Storage and DVCR Manager

The viewer preferences and program ratings monitored by the PDM are stored and managed by the Storage and DVCR Manager, or SDM.

The SDM is a machine storage manager that records and stores user program preferences. It is an independent storage module, working in conjunction with the PDM to optimize storage content. It controls access to the DVCR in the Set Top Box, recording desirable programs, either through the automatically learned set of viewer preferences provided by the PDM or through explicit viewer request.

The main control of the STB resides in a Controlling Application (CApp) which interfaces with various modules (including the SDM and PDM) of a STB to manage the aggregate functionality of a STB. The CApp manages the UI for the STB and calls the appropriate modules to execute user requests. All requests requiring DVCR functionality and recordation are directed by the CApp to the SDM. To provide DVCR functionality the SDM relies on an underlying independent DVCR library. All request to record, play, fast forward or rewind a live or recorded program are passed by the CApp to the SDM which in turn forwards them to the DVCR library with the appropriate parameters. To obtain EPG data for recording purposes the SDM assumes the availability of an external EPG library to which it make appropriate calls to retrieve required program data (it relies on the same EPG interface the PDM accesses to obtain EPG data). Control of the TV tuner for channel change purposes is done independent of the SDM by the CApp. For automatic recording of programs the SDM uses the services of the PDM and a Viewing Status Module (VSM). The PDM is used to determine the choice of programs being recorded. The VSM module determines when the viewing device

has been turned off or has become inactive so as to start the process of automatic recording and when the viewing device has been turned on or has become active to stop automatic recording.

To provide DVCR functionality the SDM relies on an underlying independent DVCR library. All user requests to record, play, fast forward or rewind a live or recorded program are passed by the CApp to the SDM, which forwards them with the appropriate parameters to the DVCR library.

The SDM is largely managed by the CApp, which controls the TV tuner for channel change and provides an EPG Database library. The SDM makes appropriate calls to the EPG library to retrieve required program data, relying on the same EPG interface that the PDM accesses.

The SDM also requires a Viewing Status Module (VSM), which tells the SDM when the viewing device, or TV screen, is inactive. Automatic recording, requested by the PDM, can only be performed by the SDM when the viewing device is off. The VSM module determines when the viewing device is inactive, so that the SDM can start automatically recording programs the viewer has requested or the PDM has determined to be desirable by examining the viewer's profile. When the viewing device becomes active the VSM stops automatic recording.

SDM Features

The SDM feature set includes these activities:

- Recording programs specified by the PDM
- Deleting stored programs, either by user request or automatically
- Providing filters that allow users to control storage policies, by choosing which factors will cause a program to be stored or deleted

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- Providing locking mechanisms that prevent the automatic deletion of stored programs if the viewer wishes to retain them

- Providing Electronic Program Guide (EPG) information for all the programs it has recorded

- Notifies the Controlling Application (CApp) of all requests that require DVCR functionality and recording

SDM Basic Operations

The SDM has two basic operations: it records programs, optimizing storage content, and it controls access to DVCR functionality.

Notice, however, that the SDM interface with the CApp provides services to two types of MbTV channel:

- live programs watched with time shift functionality. The channels on which such programs occur are called Time Shift Enabled (TSE) channels.

- Virtual Channels, which contain previously recorded material, also require SDM service functions to provide DVCR services.

Program Recording

The SDM typically initiates program recording when the VSM has determined that the viewing device (e.g. TV) is off, and while it records it generates an event list of desirable programs. When storage becomes a constraint, the SDM determines which stored programs should be deleted to make room for more desirable programs, including the viewer's explicit recording requests. The SDM stops automatic recording when the viewing device is turned on again. During such automatic recording sessions the SDM assumes that available CApp functions will enable the SDM to change channels in order to find the programs the PDM determines to be desirable.

The SDM presents programs recorded while the viewing
device is off to the viewer on virtual channels. A virtual
channel is simply a channel created by MbTV, and shown on the
EPG, on which a viewer can see what programs have been
recorded while the TV was off. Unless a viewer explicitly
requests only part of a program, the SDM considers a program
to be recorded and displays it on a virtual channel only when
the entire program has been recorded.

<u>Controlling DVCR Functionality</u>

When the viewing device is active, the SDM provides DVCR
functionality. Since the SDM manages the storage resources
and keeps track of the available space, customer applications
must pass all DVCR calls to the SDM. The DVCR library and
the SDM communicate through a set of non-blocking DVCR
service calls provided by the DVCR library, and a non-
blocking callback function provided by the SDM.

The DVCR library uses the SDM callback to return
information related to a requested DVCR operation. The
callback function indicates the completion of the current
DVCR operation, which may be triggered by an End Of File
(EOF) condition or by an explicitly requested STOP event.

The information that the SDM passes to the callback
function is context dependent. When the callback indicates
the completion of the operations fast forward, skip forward,
rewind and skip backwards, it passes the time displacements
in units of time. When it indicates completion of a
recording operation, it passes the duration of the recording.
All this information is forwarded to the CApp through CApp
callback functions.

SDM Storage Configuration

The SDM configures the storage medium through a filter
mechanism. Filters can control both the program content

recorded and the amount of storage allocated for specific
types of programs. Customer applications can use filters to

- Limit the amount of storage allocated for children's
  programs

- Prevent recording live sports programs

- Ensure a percentage of storage for situation comedies

- Prevent recordings from a specified channel

- Record all movies featuring a specific actor

Each SDM filter is associated with a specific filter
type. The CApp determines the number of filter types to
support and provides interface functions that pass
information on supported filter types. Each filter type is
identified by a unique ID number and is associated with a
single EPG parameter or set of parameters, determined by the
CApp.

The CApp invokes the SDM filter interface functions to
create and modify SDM filters, associating each filter with a
specified filter type. When the CApp creates a filter, it
coordinates the UI activities to extract the filter strings,
the associated EPG parameter, and any other relevant
parameters, and passes them to the SDM. When the SDM chooses
a program to record, it determines whether the corresponding
EPG data matches the existing filter strings and decides
whether the program should be stored. The choice of a
program to record and store depends on the current allocation
of the filter, the desired allocation of the filter, and the
maximum storage allowed by that filter.

SDM Recording Configuration

The SDM provides various mechanisms for managing
recurring requests, resolving conflicting recording requests,
providing alerts to the CApp for recording events requested
by the viewer, and controlling recording quality.

The recording quality is controlled by specifying the recording bit rate (RBR) at which a recording operation is performed. The SDM accepts various default values at which recordings may be done. These defaults are:

- System Default: This is used when no recording bit rate information is provided at the time of specifying the record request. All automatic recording requests use this value if no other default exists.

- Type Default: This value is used to specify the recording bit rate of programs of a certain type. The type of a program is derived from a set of EPG parameters specified by the Capp. The Capp specifies which EPG parameters will be taken into consideration for determining the type of a program and then specifies recording bit rate values for specific values of the chosen EPG parameters. When choosing the set of EPG parameters the CApp will not include more than a predefined number of EPG parameters and will not include parameters such as a the title, sub-title or episode-titles.

  Consider an example of an EPG where 2 of the EPG parameters are **Program Category** and **Category Type**. The possible values for the **Program Category** parameter could be **MOVIES** and **SPORTS**. The possible values for the **Category Type** parameter could be **ACTION, ADVENTURE, BASEBALL, BASKETBALL** etc. In this scenario the Capp could specify a Type Default recording bit rate for **MOVIES** & **ACTION** and a different Type Default recording bit rates for **SPORTS** & **BASKETBALL**. Any recording of programs that contain the above combination of EPG parameters would now use the applicable Type Default recording bit rate values as the default

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When the Capp makes an explicit record request and
the recording bit rate is not specified, the SDM
attempts to determine if an applicable Type Default
exists and uses it if it is available. Programs chosen
for automatic recording by the SDM also chooses a Type
Default if such an applicable default exists. The Type
Default gets precedence over the System Default.

- Program Specific: The program specific bit rate is
  specified by the Capp at the time of making an explicit
  request. This value takes precedence over all other
  default values and is used for the current recording
  and future recurring request if applicable.

The SDM provides features that accept recurring requests
for repetitive programs and overtime recordings. The CApp
provides information on the repeat rate and the time period
after which the request should be repeated. The customer can
use the overtime recording feature to cover situations in
which a program extends beyond the intended duration: sports
and political events are examples of programs whose duration
often goes over the time scheduled for them. Notice that
overtime recording allows a customer application to extend
the recording for a fixed period, but it does not provide
verification procedures that check whether a program has in
fact overrun its scheduled duration.

The SDM provides mechanisms that customer applications
can use to notify the CApp about recording conflicts. Such
conflicts can occur when either the viewer or the PDM
specifies a recording request to the SDM. Notice that the
SDM will accept an explicit recording request only if there
are no conflicts with other explicit requests that were
specified earlier. The SDM also provides notification if

there is an active viewer session at the time of executing an explicit recording request.

SDM Bit Rate Configuration

The SDM will notify the CApp if there is an active viewer session (that is, if the viewing device is on) at the time it should execute an explicit recording request.

The SDM controls recording quality by specifying the recording bit rate (RBR) at which it performs a recording operation. The SDM accepts various default values for recordings:

- System Default. This default is used when the CApp provides no recording bit rate information when requesting the recording in response to a viewer request.

- Type Default. This value provides the recording bit rate of programs of a specified type. The SDM derives the type of a program from a set of EPG parameters specified by the CApp. The CApp specifies which EPG parameters will determine the type of a program, and then provides recording bit rate values for specific values of the chosen EPG parameters. Notice that the CApp will not include more than a predefined number of EPG parameters, nor will it include such parameters as title, subtitle, or episode title.

For example, consider an EPG recording request in which two of the EPG parameters are **Program Category** and **Category Type**. Possible values for **Program Category** could be MOVIES and SPORTS. Possible values for the Category Type parameter could be ACTION, ADVENTURE, BASEBALL, BASKETBALL, or FOOTBALL. If the SDM records any programs that contain this combination of EPG parameters it uses whatever Type Default

recording bit rate values are already specified for recording movies and sporting events.

When the CApp, in response to a user event, makes an explicit record request and the recording bit rate is not specified, the SDM attempts to determine whether an applicable Type Default exists, and uses it if it is available. If the PDM chooses a program to be recorded automatically, the SDM also chooses a Type Default if an applicable Type Default exists.

The Type Default value takes precedence over the System Default value.

Program Specific Default. The CApp specifies a specific bit rate for recording a program at the time a viewer makes an explicit request. This value takes precedence over all other default values, both for the current recording and for any future recurring requests for that program.

DVCR Library

The SDM manages DVCR functionality in a set-top box through a set of service functions provided by an underlying DVCR library. DVCR requests are relayed by the CApp to the SDM, which in turn invokes DVCR functions with appropriate parameters. The CApp-SDM interface calls programs channel IDs, but the SDM-DVCR Library interface uses file names to refer to programs.

The DVCR library interfaces directly with the underlying file system for performing input/output (I/O) operations, such as file playback and recording. All functions exported by the DVCR library to the SDM are non-blocking, and return control to the caller within a fixed period of time, irrespective of the duration of the DVCR operation the SDM requests. Through background tasks, The DVCR library manages

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any extended monitoring activities that result from a DVCR request.

The DVCR library uses a callback function to communicate status and information on incoming DVCR requests and other notification events. The callback may be invoked within the context of an incoming DVCR request or from some other appropriate context. All information that the callback function passes to the SDM is described below.

All DVCR operations, once started through the DVCR library, are expected to continue until an explicit viewer request occurs to discontinue the operation. Exceptions include Beginning of File (BOF) and End of File (EOF) conditions, when the current operation can no longer be continued. Callback functions indicate these conditions to the SDM and higher modules for appropriate resolutions. When passing DVCR requests to the DVCR library, it is the responsibility of the SDM to terminate the current DVCR operation before initiating a new one. The SMD maintains DVCR information and uses it to direct the correct sequence of calls to the DVCR library.

The state diagram depicted in Fig. 50 shows the DVCR state machine implemented by the MbTV compliant DVCR library.

The boxes represent DVCR states, and the arrows represent the transitions between them. The label on each transition shows which DVCR command causes the transition, and the action the DVCR library takes as a result of that transition. If more than one DVCR command can cause a state transition, the commands are separated by a slash ("/").

In this diagram, the action taken by the DVCR library is enclosed within square brackets and in italicized characters. The action taken by the DVCR library refers to the information that the DVCR library passes through the callback

function provided by the SDM. The information shown includes
the initialization of the preEventType and eventDuration
fields of the callback data structure; the initialization of
the currEventtype is not shown in the state diagram. It is
implicitly assumed to be part of the information passed by
the DVCR library.

The various states of the DVCR library are discussed
below:

STOP CIS

A transition to the STOP CIS occurs when the current
playback operation is stopped to change the input stream
source, whether from one Virtual Channel to another or from a
Time Shifted Channel to a Virtual Channel, or vice versa. A
transition to this state occurs when a DVCRStop call occurs
and the channelChange parameter is set to TRUE (shown in the
state diagram as DVCRTStop).

STOP

A transition to the STOP state occurs when the current
DVCR operation stops, due either to an explicit user request
or to encountering an EOF/BOF condition. No change in the
input stream source is possible while in this state; any DVCR
command that follows must operate on the same input stream.
Transition to this STOP state occurs when a DVCRStop call is
made while the channelChange parameter is set to FALSE (shown
in the state diagram as DVCRFStop).

The diagram assumes that when entering the STOP state
from the TIME SHIFTED PLAY all subsequent transitions between
the STOP, VARIABLE FASTFORWARD, REWIND, and TIME SHIFTED PLAY
states refer to operations on a Time Shifted Channel,
although this is not explicitly shown. The same holds true
for transitions between the STOP, VARIABLE FASTFORWARD &
REWIND, and VIRTUAL CHANNEL PLAY states. The STOP state is

primarily intended to prevent execution of consecutive DVCR operations without an intervening DVCRStop command.

TIME SHIFTED PLAY

The TIME SHIFTED PLAY state indicates ongoing playback operations with time shift capability, when the input stream is a live source. The function DVCRFlushTSBuffer initiates.channel change operations from one Time Shifted Channel to another. These operations do not cause a state transition.

VIRTUAL CHANNEL PLAY

The VIRTUAL CHANNEL PLAY state indicates ongoing playback operations with time shift capability when the input stream is not a live source, but a prerecorded input source available on the DVCR storage media. These prerecorded input sources are also called Virtual Channels. An EOF condition Channel (shown in the state diagram as StopDueToVCEOF) causes an automatic state transition to the STOP state.

VARIABLE FASTFORWARD & REWIND

The VARIABLE FASTFORWARD & REWIND state indicates ongoing rewind or fast forward operations at variable speeds, on a Time Shifted Channel or on a Virtual Channel. An automatic transition from this state occurs when the operation encounters a BOF or EOF condition during the rewind or fast-forward operation. A BOF condition (shown in the state diagram as StopDueToBOF) causes a transition to the STOP state for both Virtual Channel and Time Shifted Channels. An EOF condition on a Virtual Channel (shown in the state diagram as StopDueToVCEOF) causes an automatic transition to the STOP state. On a Time Shifted Channel, however, an EOF condition (shown in the state diagram as StopDueToTSEOF) causes a state transition to the TIME SHIFTED

PLAY state, and the prevEventType field is set to
DVCR_JUMP_TO_LIVE.

RECORD

The RECORD state indicates an ongoing recording
operation. An EOF condition encountered during a recording
operation on a Time Shifted Channel (shown in the state
diagram as StopDueToTSEOF) causes an automatic transition to
the STOP state. This is an illegal state if the current
input stream is associated with a Virtual Channel.

PAUSE

A transition to the PAUSE state occurs when the current
playback or record operation is explicitly paused by the
user. The playback operation is valid both on a Time Shifted
Channel or a Virtual Channel, whereas the record operation
applies only to a Time Shifted Channel. Though it is not
explicitly shown, the diagram of Fig. 50 assumes that when
entering the PAUSE state from a RECORD state, the DVCRResume
command following causes a transition back to the RECORD
state. The same hold true for state transitions between the
state TIME SHIFTED PLAY & PAUSE and the state VIRTUAL CHANNEL
PLAY & PAUSE.

EOF Condition

Virtual Channels

In Virtual Channels an EOF Condition during fast-forward
and playback operations causes an automatic transition to the
STOP state. The DVCR library does not initiate an error
recovery on its own. Error recovery from such a state is
handled primarily by user intervention. Possible recovery
procedures in such a condition are rewind or channel change.

The rewind operation in such situations is a valid
operation and does not require any special handling by the
DVCR library. In the case of a channel change operation, the

Controlling Application Module forces a temporary transition to the VIRTUAL CHANNEL PLAY state (by issuing a DVCRPlay command) before entering the STOP CIS state (by issuing a DVCRStop with the channelChange parameter set to TRUE). It is assumed that a DVCRStop(True) call, invoked within a small predefined interval after issuing a DVCRPlay call, would cause a transition from the STOP state to the STOP CIS state via an intermediate VIRTUAL CHANNEL PLAY state. (This maybe achieved by delaying the indication of an EOF condition by a small interval when a DVCRPlay call is issued on an EOF condition).

Time Shifted Channels

In Time Shifted Channels, an EOF condition encountered during recording appears as an error. A lack of available recording space generates EOF conditions encountered during recording. Again, the DVCR library does not initiate an error recovery on its own and depends on the Controlling Application Module for error recovery. The Controlling Application Module can delete the channel or choose any other recovery mechanism.

EOF conditions during fast forward operations automatically transition to the TIME SHIFTED PLAY states and are indicated by a DVCR_JUMP_TO_LIVE event.

State Transitions Due to User Requests

The Controlling Application Module ensures that the sequence of commands issued to the DVCR library allows the DVCR library to maintain state and consistency with the above state diagram. At the same time, the CApp accepts any combination of DVCR requests the user issueds. For example, the Controlling Application Module accepts a user request to change to a Virtual Channel in the middle of an ongoing rewind operation in a Time Shifted Channel. The sequence of

commands issued to the DVCR Library in this specific example is:

- DVCRStop (False)

- DVCRPlay (Null, Tse_Channel, Null)

- DVCRStop (True)

- DVCRPlay ("filename", Virtual_Channel, pcontext)

The semantics of these calls are more fully described in the following sections.

Electronic Program Guide (EPG)

The Electronic Program Guide contains television program information, such as scheduled program time, program or movie titles, and channel information. The EPG library is responsible for its own data downloading mechanisms, from the internet or directly through the input stream. MbTV supplies a recommended list of channel and program parameters. Based on this list, the customer then provides a list of parameters that are applicable to the customer environment. The format of the parameter information is described in the following sections.

Some of the EPG parameters MbTV requires are mandatory. Customers must provide

- changes to the channel lineup to MbTV,

- the original EPG requirements.

- The customer must also provide unique channel Ids for the all channel information.

Tuner

The tuner provides tuning capabilities. The tuner module provides an interface for channel changing. Any channel changing the user initiates is controlled by CApp. Tuning to various channel for recording is controlled by SDM.

User Interface

User Interface is controlled by the Controlling Application CApp. It displays the various navigational screens to invoke MbTV functions. Although MbTV does not interact directly with the User Interface, MbTV has provided examples of these user interfaces to demonstrate implementation possibilities. The customers provide the presentation and navigation of the user interface, but the remote control is handled by the user interface.

O/S Support

MbTV modules run on both preemptive and non-preemptive operating systems, in real-time or non-real time environments. MbTV allocates all the resources it requires, such as memory and semaphores, during initialization. Resources cannot be dynamically allocated.

Specific operating system functions are described in the following sections. Most MbTV processing is run as low-priority background tasks. The task is either a process or a thread. The Controlling Application invokes the MbTV interface functions as foreground tasks, to synchronize access to shared objects between the foreground and background tasks. MbTV uses whatever synchronized mechanism is provided by the customer operating system. The synchronization mechanism provided by the operating system must ensure that the task holding the resource executes at the highest priority among the tasks competing for the same resources. The customer decides the priorities of all tasks, both foreground and background. MbTV schedules between three and five background tasks, the number depending on the specific MbTV implementation the customer chooses.

Data Structures

The C data structures required by the various SDM interfaces are listed below.

pgmInfo_t

The *pgmInfo_t* strcuture is used to store information on a specific TV program. Details on the *pgmInfo_t* structure are given below.

```
typedef struct _pgmInfo_
{
void*      channelID;
int   channelType;
char*      pgmTitle;
short      pgmTitleLen;
time_t     pgmStartTime;
float      pgmRating[MBTV_MAX_NUM_PROFILE];
int   pgmDuration;
int   pgmRank;
uint pgmReserved;
} pgmInfo_t, *ppgmInfo_t;
```

The semantics of the various fields in the above structure is the following.

•   *channelID* stores the channel ID associated with the channel in which the program is being played.

•   *channelType* stores the channel type as to whether refers to a live broadcast channel or a Virtual Channel for a pre-recorded program. Possible values of *channelType* are

```
#define CHANNEL_TYPE_LIVE      0x01
#define CHANNEL_TYPE_VIRTUAL  0x02
```

•   *pgmTitle* stores a pointer to a string describing the title name. It points to a valid memory location allocated by the owner of the *pgmInfo_t* structure. The number of bytes allocated for the title string is specified in the field *pgmTitleLen*.

•   *pgmTitleLen* is used both as an input and output variable. On input it specifies the number of bytes allocated

for storing the title string including the string terminator. On output it specifies the actual length of the title string. The title string is truncated if the title string length is more than the number of bytes specified in *pgmTitleLen* on input. *pgmTitleLen* is set to 0 if no program is available during the time specified in *pgmStartTime*.

- *pgmStartTime* stores the start time of the program in GMT format.

- *pgmRating* stores the MbTV generated rating for this program.

- *pgmDuration* stores the duration of the program in minutes.

- *pgmRank* stores the rank of the program in a list of specified list of programs.

- *pgmReserved* is reserved for future use and its contents are ignored by the PDM.

recRequest_t

The *recRequest_t* structure used by the CApp to specify a record request is described below.

```
typedef struct _recRequest_
{
ulong       requestID;
void*       channelID;
char title[MBTV_MAX_TITLE_LEN];
ulong       recBitRate;
time_t      pgmStartTime;
time_t      recStartTime;
time_t      recEndTime;
time_t      repeatTill;
int   repeatRate;
#define REPEAT_WEEKLY     0x01
#define REPEAT_DAILY      0x02
```

```
#define REPEAT_ANYTIME    0x03
ulong      flag;
#define OVERTIME_RECORDING    0x01
#define DELETE_REQUEST    0x02
#define PURGE_REQUEST    0x04
#define SKIP_NEXT    0x08
} recRequest_t, *precRequest_t;
```

The semantics of the various fields in the above structure is the following.

- *chnlID* stores the channel ID of the channel associated with the program being recorded.

- the *title* field stores that title of the program being recorded.

- the *recBitRate* field stores the bit rate at which the program is being recorded. When set to 0, a default recording bit rate is chosen. This value is passed by the Capp and is presented as-is to the DVCR library by the SDM without interpretation.

- the *pgmStartTime* field indicates program start time in local time. This is the actual start time of the program.

- the *recStartTime* field indicates recording start time in local time. By default, the recording start time is the start time of the program.

- the *recEndTime* field stores the recording end time in local time and by default it does not exceed beyond the playing time of the program.

- *repeatTill* stores the date in (yymmdd format) till which the request will be repeated and is valid only for recurring programs.

- *repeatRate* stores the time intervals between the recordings. When set to *REPEAT_ANYTIME*, the record request is executed whenever the program is available in the channel

specified by the *chnlID* field. Program availability is checked in the specified channel only and would require multiple record requests with appropriate channel ids for scanning availability in multiple channels.

• the *flag* is a bit wise field and is used to communicate modifications in user requests. The *OVERTIME_RECORDING* bit is used to specify overtime recording (ie record a fixed number of seconds beyond the end time). The *DELETE_REQUEST* is used to delete a record request, whereas the *PURGE_REQUEST* is used to remove the request from the request list. In both cases the recording request is cancelled. However requests with the *DELETE_REQUEST* bit set can be modified to unset the *DELETE_REQUEST* bit. The *SKIP_NEXT* bit is applicable for recurring requests only. When set, by the Capp, the next occurrence of the program is not recorded and is cleared by the SDM.

cBackInfo_t

The C structure used by the SDM for event notifications to the CApp to indicate start or a completion of a DVCR operation is given below.

*typedef struct _cBackInfo_*

{

int   currEventType;

int   prevEventType;

time_t   eventTime;

time_t   eventDuration;

void   channelID;*

int   channelType;

int   errorNum;

int   reserved

*} cBackInfo_t, *pcBackInfo_t;*

The semantics of the various fields in the above structure is the following.

- *currEventType* stores the event type which invoked the callback. Possible values for *currEventType* are

    #define SDM_REWIND 1

    #define SDM_FAST_FORWARD 2

    #define SDM_STOP   3

    #define SDM_PAUSE   4

    #define SDM_RESUME 5

    #define SDM_PLAY   6

    #define SDM_JUMP_TO_LIVE 7

    #define SDM_ADD_CHANNEL 8

    #define SDM_DELETE_CHANNEL   9

    #define SDM_IMPLICIT_STOP   10

    #define SDM_RECORD 11

    #define SDM_SKIP_FORWARD 12

    #define SDM_SKIP_BACKWARD   13

    #define SDM_RECORD_ALERT 14

- the *prevEventType* field is valid only if the *currEventType* is set to *SDM_PAUSE, SDM_STOP* or *SDM_IMPLICIT_STOP.* The *prevEventType* stores the DVCR operation that has been stopped or paused explicitly by a requested stop operation or implicitly by an EOF condition. Legal values of *prevEventType,* when *currEventType* is set to *SDM_STOP* or *SDM_IMPLICIT_STOP,* are *SDM_FAST_FORWARD, SDM_REWIND, SDM_PLAY* and *SDM_RECORD.* Legal values of *prevEventType,* when *currEventType* is set to *SDM_PAUSE,* are *SDM_PLAY,* and *SDM_RECORD.*

- *eventTime* stores the time in GMT format at which event occurred.

- The information in *eventDuration* field is context dependent. When *prevEventType* is set to *SDM_REWIND* or

SDM_FAST_FORWARD eventDuration stores the amount of time (in seconds) by which the current program has been rewound or fast forwarded. When *prevEventType* is set to *SDM_PLAY* or *SDM_RECORD, eventDuration* contains the playback duration or recording duration. When *currEventType* is set to *SDM_RESUME eventDuration* contains the playback duration or recording duration depending on the operation that was resumed. The SDM does not provide information on the operation which has been resumed and assumes that the callback target maintains the necessary context information. When *currEventType* is set to *SDM_SKIP_BACKWARD* or *SDM_SKIP_FORWARD*, the duration field is set to the amount of time that has been skipped backward or skipped forward respectively.

- *channelType* stores the channel type as to whether refers to a live broadcast channel or a Virtual Channel for a pre-recorded program. Possible values of *channelType* are

  #define CHANNEL_TYPE_LIVE   0x01

  #define CHANNEL_TYPE_VIRTUAL   0x02

- *channelID* stores the channel ID of the channel associated with the event. The *channelID* field is valid only if the *channelType* is set to *CHANNEL_TYPE_VIRTUAL.*

- the *errorNum* field is used to indicate an error condition which occurred when executing the DVCR request.

  sdmCBackInfo_t

  The C structure used by the DVCR Library for event notifications to the SDM to indicate completion of a DVCR operation is as given below. This structure is identical to the *cBackInfo_t* structure used by the SDM for CApp notification with the exception of an additional context field.

  *typedef struct _sdmCBackInfo_*

  {

```
cBackInfo_t      commomData;
ulong      context;
} sdmCBackInfo_t, *psdmCBackInfo_t;
```

The semantics of the various fields in the above structure is the following.

- the *commonData* field of type a *cBackInfo_t* structure. The callback status and information passed by the SDM to the CApp is almost identical to that passed by the DVCR Library to the SDM.

- *currEventType* field in the *commomData* stores the event type which invoked the callback. Possible values for *eventType* are

```
#define DVCR_REWIND 1
#define DVCR_FAST_FORWARD      2
#define DVCR_STOP    3
#define DVCR_PAUSE   4
#define DVCR_RESUME 5
#define DVCR_PLAY      6
#define DVCR_JUMP_TO_LIVE      7
#define DVCR_IMPLICIT_STOP      8
#define DVCR_RECORD 9
#define DVCR_SKIP_FORWARD      10
#define DVCR_SKIP_BACKWARD      11
```

- the *context* field is set by the DVCR library and is passed by the DVCR library when the current DVCR operation (rewind, fast-forward or playback) is terminated for a program on a Virtual Channel. This context is passed back to the DVCR when a playback operation is resumed.

filterType_t

The C structure for storing filter type information is given below. The CApp determines the number of filter types that are to be supported and it uses the *filterType_t*

structure to pass filter type information to the SDM. Some examples of filter types are PROGRAM TYPE, PROGRAM CHANNELS, PERFORMERS, PARENTAL RATING etc.

```
typedef struct _filterType_
{
ulong      filterTypeID;
int   numEPGParams;
int   epgParamNums[MBTV_MAX_NUM_SFILTER];
int   epgDataType;
#define    MBTV_TYPE_CHAR 1
#define    MBTV_TYPE_INT16     2
#define    MBTV_TYPE_INT32     3
#define    MBTV_TYPE_UINT16    4
#define    MBTV_TYPE_UINT32    5
#define    MBTV_TYPE_SUBSTRING 6
#define    MBTV_TYPE_STRING    7
char filterTypeName[MBTV_MAX_FTYPE_NLEN];
} filterType_t, *pfilterType_t;
```

The semantics of the various fields in the above structure is the following.

• the *filterTypeID* uniquely identifies each filter type. This field is passed to the SDM when creating SDM filters.

• the *numEPGParams* field specifies the number of EPG parameters associated with this filter type.

• the *epgParamNums* array stores the EPG parameters associated with this filter type. Most filter types are associated with a single EPG parameter, however there are instances of a single filter type being mapped to multiple EPG parameters provided all the mapped EPG parameters are of the same data type. A typical example of a filter type that

is associated with multiple EPG parameters is PERFORMERS. EPG data for movies usually contain names of multiple performers.

- the *epgDataType* field stores the data type of the EPG parameters associated with the filter type. In scenarios where multiple parameters are mapped to a single filter type, all the mapped EPG parameters must be of the same data type. Details on the data types enumerated above are as below

- *MBTV_TYPE_CHAR* to specify a single byte character.

- *MBTV_TYPE_INT16* to specify a 2 byte integer

- *MBTV_TYPE_INT32* to specify a 4 byte integer

- *MBTV_TYPE_UINT16* to specify a 2 byte unsigned integer

- *MBTV_TYPE_UINT32* to specify a 4 byte unsigned integer

- *MBTV_TYPE_STRING* to specify a NULL terminated string (to specify whole string matches)

- *MBTV_TYPE_SUBSTRING* to specify a NULL terminated substring (to specify matches with a part of a string).

- the *filterTypeName* stores the name of the filter type in a NULL terminated string.

filter_t

The C structure used to store filter information is given below.

*typedef struct _filter_*

{

ulong   filterID;

int userID;

ulong   filterTypeID;

char filterString[MBTV_MAX_NUM_SFILTER]
*   [MBTV_MAX_SFILTER_PLEN];*

int   currAllocation;

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```
int  maxAllocation;

int  desiredAllocation;

} filter_t, *pfilter_t;
```

The semantics of the various fields in the above structure are described in the preceding Filters and Storage Configuration section. As in the case of the *pgmInfo_t* structure, the owner of the *filter_t* structure ensures that *filterString* point to a valid memory location allocated by the owner. The semantics of the various fields in the above structure is the following.

- the *filterID* field uniquely identifies the filter.

- the *userID* field uniquely identifies the user profile with which this filter is associated. This field is currently unused.

- the *filterTypeID* identifies the filter type associated with this filter. The *filterTypeID* is used to get information on which parameters of the EPG yield information corresponding to this filter.

- the *filterString* array field stores the filter string associated with the filter. The CApp converts non-string data into a NULL terminated string before being passed it in the *filter_t* structure. If the filter type corresponds to **Program Channel,** possible values for filter string could be CNN, TNT etc. Alternatively if the filter type corresponds to **Program Type,** possible values for filter string could be sitcoms, talk show etc. The number of strings specified in the *filterString* array could be less than or equal to the number of EPG parameters specified in the associated filter type. For filter types which are mapped to multiple EPG parameters, each string passed in *filterString* array is searched in all the EPG parameters specified in the associated filter type.

• the *currAllocation* field specifies how much of storage space has already been allocated to TV programs whose EPG parameters match this filter.

• the *maxAllocation* field specifies the maximum allocation allowed for this filter

• the *desiredAllocation* field specifies the amount storage space that should be reserved for TV programs whose EPG parameters match this filter.

tdBitRate_t

This C structure is used to pass bit rate values for specific values of the chosen Type Default EPG parameters. This bit rate is chosen when recording a program whose EPG parameters matches the corresponding EPG parameter values specified in this structure.

*typedef struct _tdBitRate_*

{

    ulong   tdBitRateID;

ulong   filterTypeID;

    ulong   bitRate;

    char tdValues[MBTV_MAX_NUM_TDEF_PARAMS]

[MBTV_MAX_TDEF_PLEN];

*} tdBitRate_t, *ptdBitRate_t;*

The semantics of the various fields in the above structure is the following.

• the *tdBitRateID* field uniquely identifies this Type Default bit rate.

• the *filterTypeID* field uniquely identifies the EPG parameters associated with this Type Default bit rate.

• the *bitRate* field specifies the recording bit rate for the EPG parameter values specified in this structure.

• the *tdValues* array specifies the EPG parameter values associated with this Type Default bit rate. Each value

is specified as a NULL terminated string and is associated with the corresponding EPG parameter specified in the *pgmTDparams_t* structure.

sbudget_t

This C structure is used to store the recording space allocated for a PDM profile. The space allocated is specified as a percentage of the total available recording space.

```
typedef struct _sbudget_
{
        ulong       profileID;
        int   spaceAllocated;
} sbudget_t, *psbudget_t;
```

The semantics of the various fields in the above structure is the following.

• the *profileID* field uniquely identifies the profile for which the recording space is allocated.

• the *spaceAllocated* field specifies the amount of space allocated for the corresponding profile as a percentage of the total recording space available.

VSM Events

Every user request generated during a viewing session are indicated to the VSM in the form of an event. The events indicated by the CApp to the VSM are listed below.

```
#define MBTV_POWER_ON       1
#define MBTV_POWER_OFF      2
#define MBTV_REWIND 3
#define MBTV_FAST_FORWARD       4
#define MBTV_PAUSE   5
#define MBTV_RESUME 6
#define MBTV_PLAY       7
#define MBTV_JUMP_TO_LIVE       8
#define MBTV_CHANNEL_CHANGE     9
```

```
#define MBTV_ADD_CHANNEL 10
#define MBTV_DEL_CHANNEL 11
#define MBTV_STOP     12
#define MBTV_RECORD 13
#define MBTV_SKIP_FORWARD     14
#define MBTV_SKIP_BACKWARD     15
```

Of the events listed above the *MBTV_ADD_CHANNEL* event is not indicated to the VSM and has been included here for the sake of completeness. Indication of *MBTV_POWER_ON* and *MBTV_POWER_OFF* by the CApp are optional depending on availability of hardware support. *MBTV_DEL_CHANNELS* events are indicated only when programs are deleted explicitly by user request. Automatic program deletions by the SDM are not indicated to the VSM.

SDM Interfaces

The SDM interacts with the other modules in a STB through specific well defined interfaces. Details on these interfaces are given in the sections below. In the interface functions defined below unless otherwise stated it is assumed that all pointers that are passed as I/F function parameters point to a valid memory location allocated by the caller in its own address space.

SDM & CApp Interface

This interface is primarily used for invocation of SDM service functions by the CApp and event notification by the SDM to the CApp.

SDM services are required for live programs that are watched with time shift functionality enabled. Live channels when viewed with the time shift functionality enabled are also referred to as Time Shift Enabled (TSE) channels. The time shift capability of a TSE channel is achieved by performing a record operation of the program's audio/video

stream and providing simultaneous DVCR services on the recorded stream. The recorded audio/video stream is stored as a circular buffer in a file allocated for this purpose. In terms of file I/O time shifted functionality is equivalent to maintaining a set of 2 file pointers, viz - a write pointer which controls the record operation and a read pointer which controls the playback, fast-forward and rewind operation. The duration for which such live programs are stored is determined by the size of circular buffer.

SDM service functions also provide DVCR services for pre-recorded programs made available on Virtual Channels. The SDM generates a Virtual Channel for each recorded program. Unlike TSE Channels which require simultaneous read and write capability, Virtual Channels require only read capability to be operational.

All SDM functions are non-blocking and control is returned to the caller within a fixed period of time. Details on the service functions provided by the SDM are given below

SDMStop

int SDMStop(boolean channelChange)

Called by the CApp to terminate the current DVCR operation which could be a playback, rewind, fast-forward or record operation being performed on a Virtual Channel or a TSE Channel. The CApp must ensure that the current DVCR operation is stopped by invoking *SDMStop* before a new one is started. The current DVCR operation should be stopped by an explicit user request or implicitly by the CApp. For example in a possible scenario of 2 successive DVCR requests of playback and rewind, the CApp should issue a *SDMStop* call to stop the playback operation before generating the new rewind request. Status and other information on the DVCR operation

that has been terminated is communicated to the CApp by posting an *SDM_STOP* event through the CApp callback routine. In case of successful completion of a record operation an additional *SDM_ADD_CHANNEL* event is returned after indicating a *SDM_STOP* event.

The *SDMStop* function is also called by the CApp during a channel change operation from a TSE or Virtual Channel. The input parameter *channelChange* is set to TRUE when *SDMStop* is invoked for the purpose of a channel change operation and is set to FALSE otherwise. No callback to the CApp is generated if *channelChange* is set to TRUE.

On success it returns a zero value and non-zero error value otherwise.

SDMPlay

int SDMPlay(int chnlID, int channelType, boolean channelChange)

The CApp calls this function when changing the channel to a Virtual Channel or when changing the channel from a Virtual Channel to TSE Channel. This function is also called to pass an explicit playback request on a Virtual Channel or a TSE Channel. (For channel change operations from one TSE channel to another TSE channel, the CApp invokes *SDMFlushTSBuffer*.) When passing an explicit playback request, the *chnlID* parameter is set to NULL. The input parameter *channelChange* is set to TRUE when *SDMPlay* is invoked for the purpose of a channel change and is set to FALSE otherwise. The input parameter *channelType* is used to indicate whether the playback operation is requested for a TSE channel (*CHANNEL_TYPE_LIVE*) or a Virtual Channel (*CHANNEL_TYPE_VIRTUAL*). In case of changing to a Virtual Channel, the virtual channel ID (which was passed to the CApp by the SDM in an earlier call) is passed as input in the

chnlID parameter. When changing the channel to a TSE channel, the *chnlID* parameter is set to NULL. Controlling the tuner device to change the channel to or from a live broadcast channel is handled independently by the CApp.

Once the *SDMPlay* function is invoked for a Virtual Channel, playback continues till either it is terminated by an explicit *SDMStop* invocation or an End-Of-File condition has been reached. In case of a TSE Channel playback operation continues till the channel is changed. The SDM assumes that playback function will always be terminated (either due to an EOF condition or explicit request) before the CApp performs a channel change operation.

The *SDMPlay* function generates a *SDM_PLAY* event for the CApp only when it is invoked with the *channelChange* parameter set to FALSE.

On success it returns a zero value and non-zero error value otherwise.

SDMDelete

int SDMDelete(int chnlID, int chnlType)

The CApp calls this function to delete a recorded program. The program to be deleted is identified by the specified channel ID. If the channel ID corresponds to a live broadcast channel, no action is taken. The CApp must ensure that the Virtual Channel associated with the recorded program is not active at the time of presenting the delete request. Delete request for currently active stored programs are returned with an error status.

The *SDMDelete* function generates a *SDM_DELETE_CHANNEL* event for the CApp.

On success it returns a zero value and non-zero error value otherwise.

SDMPause

int SDMPause(void)

The CApp calls this function to pause playback or recording on the current channel. For pausing playback the current channel could correspond to a Virtual Channel for a pre-recorded programs or a TSE Channel. It does not have effect on rewind and fast-forward operations.

The *SDMPause* function generates a *SDM_PAUSE* event for the CApp. It also returns information on the duration of the preceding playback or recording operation.

On success it returns a zero value and non-zero error value otherwise.

SDMResume

int SDMResume(void)

The CApp calls this function to resume the playback or recording of a previously paused operation on the current channel. The current channel could correspond to a Virtual Channel for a pre-recorded programs or a TSE Channel. It does not have effect on rewind and fast-forward operations.

The *SDMResume* function generates a *SDM_RESUME* event for the CApp.

On success it returns a zero value and non-zero error value otherwise.

SDMFastForward

int SDMFastForward(ulong privateData)

The CApp calls this function to do a fast-forward operation on the current channel. The *privateData* parameter is used by the Capp to pass information directly to the DVCR library. The *SDMFastForward* function passes this parameter directly to the DVCR library without any modifications. This parameter maybe used to pass the fast forward speed or any other data specific to the DVCR library. Additionally consecutive invocations of the *SDMFastForward* function are

passed directly to the DVCR library for further processing. The DVCR library may use these consecutive invocations to modify the operation of the ongoing fast forward request if it so desires.

The current channel on which the fast forward operation is being done could correspond to a Virtual Channel for a pre-recorded programs or a TSE Channel. Fast forward operations on a Virtual Channel can be carried out till an EOF condition occurs. For TSE Channels, the fast forward operation can be carried on till the end of the circular buffer.

The *SDMFastForward* function generates a *SDM_FAST_FORWARD* event for the CApp. The total duration, in seconds, of the fast forward operation is returned in the callback for the *DVCR_STOP* and *DVCR_IMPLICIT_STOP* events.

On success it returns a zero value and non-zero error value otherwise.

SDMRewind

int SDMRewind(ulong privateData)

The CApp calls this function to do a rewind operation on the current channel. The *privateData* parameter is used by the Capp to pass information directly to the DVCR library. The *SDMRewind* function passes this parameter directly to the DVCR library without any modifications. This parameter maybe used to pass the rewind speed or any other data specific to the DVCR library. Additionally consecutive invocations of the *SDMRewind* function are passed directly to the DVCR library for further processing. The DVCR library may use these consecutive invocations to modify the operation of the ongoing rewind request if it so desires.

The current channel on which the rewind operation is being done could correspond to could correspond to a Virtual

Channel for a pre-recorded program or a TSE Channel. Rewind operations on a Virtual Channel can be carried out till a BOF (Beginning-Of-File) condition occurs. For TSE Channels, the rewind operation can be carried on till the beginning of the circular buffer.

The *SDMRewind* function generates a *SDM_REWIND* event for the CApp. The total duration, in seconds, of the rewind operation is returned in the callback for the *SDM_STOP* and *SDM_IMPLICIT_STOP* events.

On success it returns a zero value and non-zero error value otherwise.

SDMSkipForward

int SDMSkipForward(int duration)

The CApp calls this function to do a skip forward operation on the current channel. The amount skipped is specified by the input parameter duration in seconds. Unlike a fast-forward operation, skip forward does not display intermediate frames. The current channel could correspond to a Virtual channel for a pre-recorded programs or a TSE Channel.

The *SDMSkipForward* function generates a *SDM_SKIP_FORWARD* event for the CApp and includes information on the length of time that has been skipped forward.

On success it returns a zero value and non-zero error value otherwise.

SDMSkipBackward

int SDMSkipBackward(int duration)

The CApp calls this function to do a skip backward operation on the current channel. The amount skipped is specified by the input parameter *duration* in seconds. Unlike a rewind operation, skip backward does not display intermediate frames. The current channel could correspond to

a Virtual Channel for a pre-recorded programs or a TSE Channel.

The *SDMSkipBackward* function generates a *SDM_SKIP_BACKWARD* event for the CApp and includes information on the length of time that has been skipped backward.

On success it returns a zero value and non-zero error value otherwise.

SDMLive

int SDMLive(void)

This command is relevant only for TSE Channels. When viewing a program in time-shifted mode, this calls starts displaying live frames from the end of the circular buffer.

The *SDMLive* generates the *SDM_JUMP_TO_LIVE* event for the CApp.

On success it returns a zero value and non-zero error value otherwise.

SDMFlushTSBuffer

int SDMFLushTSBuffer()

The *SDMFlushTSBuffer* function flushes the time shift buffer associated with a TSE channel. The CApp calls this function when performing a channel change operation from a TSE channel to another TSE channel.

The *SDMFlushTSBuffer* does not generate any event notification for the CApp. On success it returns a zero value and non-zero error value otherwise.

SDMRecord

int SDMRecord(precRequest_t pRecordRequest, int conflictOverride,

*precRequest_t pConflictingRequest, ulong *requestID)*

The CApp calls this function to send a request to record a broadcast program. The record request could specify an

immediate recording operation on a currently available program or for a program available in future. This function is not invoked for resuming a paused recording operations.

A pointer to the record request structure is passed in the parameter *pRecordRequest*. The *chnlID*, *title* and *startTime* fields are filled by the caller. Initializing the *endTime* field is optional and by default is set to the end of the program. If the *chnlID* corresponds to a Virtual Channel, no action is taken. If the *startTime* and *endTime* are set to *NULL* values the record request is executed immediately on the current channel. Such immediate request automatically override any conflicting record requests specified earlier.

If the specified record request is not an immediate request and conflicts with a prior request, *SDMRecord* returns a non-zero value and initializes the recRequest_t structure, allocated by the caller, and pointed to by *pConflictingRequest* to contain information on the conflicting request and the *requestID* parameter is set to *NULL*. In the absence of request conflicts, *SDMRecord* initializes the *requestID* parameter to a non *NULL* value.

The *conflictOverride* parameter when set to TRUE is used to override the conflict with the program specified by *pConflictingRequest*. When *conflictOverride* is set to TRUE and *pConflictingRequest* refers to a valid conflicting program, the conflicting request is removed from the list of requests and the record request is added. In case of multiple conflicts, this process is repeated till all conflicts are resolved.

For immediate record requests the *SDMRecord* generates an *SDM_RECORD* event for the CApp to indicate the start of the record operation. Such immediate record requests take precedence over all conflicting requests if any. The

recording operation is continued till explicitly stopped by the user or due an implicit stop condition generated by an EOF condition. No events are generated by this function otherwise.

On success it returns a zero value and non-zero error value otherwise. If successful it sets the input parameter *requestID* to the ID for the request. The request ID is required for all future references to this record request.

SDMGetNumRecConflicts

SDMGetNumRecConflicts(precRequest_t pRecordRequest,

*int *cntConflicts)*

This function returns the number of explicit recording requests that conflicts with the specified input recording request.

The *SDMGetNumRecConflicts* does not generate any event for the CApp.

On success it returns a zero value and sets the input parameter *cntConflicts* to the number of explicit record request that conflict with the specified recording request. A non-zero error value is set in case of error.

SDMGetRecConflicts

int SDMGetRecConflicts(precRequest_t pRecordRequest,

int conlfictNum,

precRequest_t pConflictingRequest,)

This function returns an explicit request that conflicts with the specified input recording request. The conflicting request that is to be returned is specified by the caller in the *conlfictNum* parameter. *conlfictNum* ranges from 0 to **N**-1 where **N** is the number of conflicting requests returned by *SDMGetNumRecConflicts.* If *conlfictNum* is set **N** or higher an error is returned.

The *SDMGetRecConflicts* does not generate any event for the CApp.

On success it returns a zero value and initializes the input parameter recRequest_t structure, alllocated by the caller, and pointed to by *pConflictingRequest* to contain information on the conflicting request. A non-zero error value is set in case of error.

SDMGetNumRecRequests

*int SDMGetNumRecRequests(int *cntRequest)*

This function returns the number of explicit record request currently outstanding. Unless explicitly deleted by the CApp, each record request is automatically deleted on completion of the record request.

The *SDMGetNumRecRequests* does not generate any event for the CApp.

On success it returns a zero value and sets the input parameter cntRequest to the number of outstanding explicit record request. A non-zero error value is set in case of error.

SDMGetRecRequestID

*ulong SDMGetRecRequestID(int num, ulong *requestID)*

SDMGetRecRequestID returns the ID associated with a request. The input parameter is an integer between 0 & **N-1** where **N** is the return value of the *SDMGetNumRecRequests* call. It should be noted that there is no relationship between the specified input integer and the request ID returned by this function. As more requests are added and deleted the same value of the num parameter might yield different values of requests ID's at different times. However each request ID will always be associated with the same request.

The *SDMGetRecRequestID* does not generate any event for the CApp.

On success it returns a zero value and sets the value of the *requestID* parameter. A non-zero error value is returned in case of error.

SDMGetRecRequest

int   SDMGetRecRequest(ulong   reqID,   precRequest_t precRequest)

This function returns information on the request associated with the specified request ID by initializing the fields of the *recReqData* structure pointed to by *precRequest*. The caller ensures that *precRequest* points to a valid *recReqData* structure.

The SDMGetRecRequest does not generate any event for the CApp.

On success it returns a zero value and non-zero error value otherwise.

SDMSetRecRequest

int   SDMSetRecRequest(ulong   reqID,   precRequest_t precRequest,

　　　　　precRequest_t pConflictingRequest,

　　　　　int conflictOverride)

The *SDMSetRecRequest* allows the CApp to modify a record request. The request to be modified is identified by the input parameter *reqID* and the *precRequest* parameter points to the modified *recRequest_t* structure. The fields which can be modified are *startTime*, *endTime*, *repeatTill*, *repeatRate* and flag fields. *startTime* and *endTime* can be set to any time within the playing duration of the program provided *startTime* is less than *endTime*. The *repeatTill* field should be filled in local time format and the *repeatRate* can be set to *REPEAT_DAILY* or *REPEAT_WEEKLY*. The flag field can be modified to set or clear the *OVERTIME_RECORDING*, *DELETE_REQUEST* and *PURGE_REQUEST* bits. Setting any other bits in this field is

returned as error. The *chnlID* and title fields should not be modified. All illegal modification are returned as error.

If the modified request results in a conflict with an existing record request, an error is returned and the recRequest_t structure, allocated by the caller, and pointed to by the *pConflictingRequest* parameter is initialized with information on the conflicting program. If the specified modification does not conflicts with any existing request, all fields in the *pConflictingRequest* structure are set to zero or *NULL*.

If the *conflictOverride* parameter is set to TRUE and *pConflictingRequest* is associated with a valid conflicting explicit request, the record request associated with *precRequest* is preferred over the conflicting request. If multiple conflicting requests exist, the *SDMSetRecRequest* will have to be invoked multiple times.

The *SDMSetRecRequest* does not generate any event for the CApp.

On success it returns a zero value and non-zero error value otherwise.

SDMDelRecRequest

int SDMDelRecRequest(ulong reqID)

A prior record request can be deleted by calling the *SDMDelRecRequest* call. The request to be deleted is specified by the *reqID* input parameter.

The *SDMDelRecRequest* does not generates any event for the CApp.

On success it returns a zero value and non-zero error value otherwise.

SDMGetAutoRecordStatus

*int SDMGetAutoRecordStatus(int *status)*

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The CApp calls this function to determine if automatic recording is enabled. Possible values for status is are

#define AUTO_RECORD_ENABLE   0x1

#define AUTO_RECORD_DISABLE   0x2

On success it returns a zero value and non-zero error value otherwise.

SDMSetAutoRecordStatus

int SDMSetAutoRecordStatus(int cmd)

The CApp calls this function to enable or disable automatic recording. When automatic recording is disabled, recording is done only explicit record request. The input parameter *cmd* is set to the values defined above.

On success it returns a zero value and non-zero error value otherwise.

SDMSetRBRDefault

int SDMSetRBRDefault(ulong bitRate)

The Capp calls this function to set the default bit rate, in the parameter *bitRate*, for recording operations. This bit rate is passed by the SDM to the DVCR library as the default value when no bit rate is specified during a record operation. This parameter is passed directly to DVCR library when issuing record request to the DVCR library. The SDM does not process or attempt to validate the semantics of the specified parameter.

The Capp must not use a direct interface to the DVCR library to specify the default bit rate.

On success it returns a zero value and non-zero error value otherwise.

SDMGetRBRDefault

*int SDMGetRBRDefault(ulong *bitRate)*

The Capp calls this function to get the default bit rate, in the parameter *bitRate*, currently used by the SDM

when making record requests to the DVCR library. A value of 0 is returned in the *bitRate* parameter if no default bit rate has been specified to SDM by the Capp or during intialization.

On success it returns a zero value and non-zero error value otherwise.

SDMGetNumTDRBR

*int SDMGetNumTDRBR(int *cntTDrbr)*

The Capp calls this function to get the number of Type Default recording bit rates (RBR) that have currently been specified to the SDM. The input parameter *cntTDrbr* is used to return the number of Type Default recording bit rates currently available.

On success it returns a zero value and non-zero error value otherwise. The input parameter *cntTDrbr* is set when returning success.

SDMGetTDRBRid

*int SDMGetTDRBRid(int num, ulong * tdRBRID)*

SDMGetTDRBRid returns a unique Type Default RBR Id for the input number specified by the parameter *num*. The value of *num* ranges from 0 to N-1 where N is the number of Type Default RBR returned by the *SDMGetNumTDRBR* call. All future references to this RBR is based on the RBR id returned by *SDMGetTDRBRid*.

On success it returns a zero value and sets the input paramter *tdRBRID* to the corresponding RBR id. A non-zero error value is returned otherwise.

SDMGetTDRBR

int SDMGetTDRBR(ptdBitRate_t ptdBitRate)

SDMGetTDRBRid returns the RBR and the Type Default EPG parameter values associated with the Type Default RBR specified as input. The caller sets the *tdBitRateID* field in

the *ptdBitRate_t* structure pointed to by input parameter *ptdBitRate*. The *SDMGetTDRBRid* sets all the other fields of this structure associated with the specified ID.

On success it returns a zero value and sets the fields of the input *ptdBitRate_t structure.* A non-zero error value is returned otherwise.

SDMSetTDRBR

int SDMSetTDRBR(ptdBitRate_t ptdBitRate)

SDMSetTDRBRid sets or updates the RBR and the values for Type Default EPG parameters for the Type Default RBR specified in the *tdBitRateID* field in the *ptdBitRate_t* structure specified as input. The caller sets the *tdBitRateID* field in the *ptdBitRate_t* structure and all the other fields pointed to by input parameter *ptdBitRate.*

On success it returns a zero value and sets the RBR and the values of the EPG parameters for the specifed Type Default RBR. A non-zero error value is returned otherwise.

SDMCreateTDRBR

*int   SDMCreateTDRBR(ulong   *   tdRBRID,   ptdBitRate_t ptdBitRate)*

SDMCreateTDRBR creates a new Type Default RBR and returns the associated ID for the RBR in the input parameter *tdRBRID*. The CApp passes the RBR and the values for the Type Default EPG parameters in *tdBitRate_t* structure pointed to by the input parameter *ptdBitRate*. These values are used to setup the newly created RBR if the *SDMCreateTDRBR* call succeeds.

On success it returns a zero value and sets the RBR ID in the *tdRBRID* parameter. A non-zero error value is returned otherwise

SDMDeleteTDRBR

int SDMDeleteTDRBR(ulong tdRBRID)

SDMDeleteTDRBR deletes the Type Default RBR specified by the input parameter *tdRBRID.*

On success it returns a zero value and deletes the RBR ID specified by the *tdRBRID* parameter. A non-zero error value is returned otherwise

SDMMakeStorageList

*int   SDMMakeStorageList(time_t   recStartTime,   ulong *cookie)*

This function is called to generate the list of programs that will be recorded by the SDM from the time specified by the parameter *recStartTime.* Programs maybe chosen automatically based on user preference or due to an explicit request. This function is typically called when the viewing device is turned off so that the SDM may initiate the activities for program recordation. A cookie is returned by this function which is required for future access to the list generated by *SDMMakeStorageList.*

On success it returns a zero value and non-zero error value otherwise.

SDMGetStorageListSize

int   SDMGetStorageListSize(time_t   displayTime,   ulong cookie,

*int *cntRecPgm)*

This function returns the number of recorded programs that will be available in the SDM storage at the time specified by the parameter displayTime. The cookie returned by the *SDMMakeStorageList* is passed as an input to the *SDMGetStorageListSize* call.

On success it returns a zero value and initializes the *cntRecPgm* parameter and non-zero error value otherwise.

SDMGetStorageList

int SDMGetStorageList(time_t displayTime, ulong cookie,

pgmInfo_t **pgmInfo)

This function is called to determine the list of recorded programs that will be available at the time specified by the parameter *displayTime*. The number of programs that will be returned in the list of recorded programs is set to **N** where **N** is the return value of the preceding *SDMGetStorageListSize* call. The list of programs is returned in an array of pointers of type *pgmInfo_t* specified by the *pgmInfo* parameter. The caller ensures that each pointer in the array points to a valid *pgmInfo_t* structure. The cookie returned by the *SDMMakeStorageList* is passed as an input to the *SDMGetStorageList* call.

On success it returns a zero value and non-zero error value otherwise.

SDMGetProgReqInfo

int SDMGetProgReqInfo(pgmInfo_t *pgmInfo, int *info)

This function is called by the CApp to get information on any requests associated with the program specified by the input parameter *pgmInfo*. The *info* parameter returns information on whether a recorded program has been explicitly locked or whether there has been a record request on a broadcast program. The possible values for the *info* parameter are

#define RECORD_REQUESTED 0x01

#define PROGRAM_LOCKED   0x02

A value of *PROGRAM_LOCKED* is returned if the program has been locked by explicit request. Such locked programs are not deleted immediately for purposes of automatic recording. This value is meaningful for Virtual Channels (ie recorded programs) only. A value of *RECORD_REQUESTED* is returned if there is an explicit record request pending for that program. For recorded programs on Virtual Channels a value of

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RECORD_REQUESTED is returned if the program was recorded due to an explicit request. This value is meaningful both for live and recorded programs.

This function is provided for the CApp if it wishes to visually indicate such information when displaying EPG information. When getting program information for Virtual Channels, specifying the Virtual Channel ID in the *channelID* field of the *pgmInfo_t* structure is sufficient. For live programs, the *channelID*, *pgmStartTime* and *pgmTitle* must be set by the caller.

On success it returns a zero value and non-zero error value otherwise.

SDMGetLockStatus

int SDMGetLockStatus(void* vchannelID, int *flag)

This function is called to determine if there is an explicit lock request for the recorded program available in the Virtual Channel specified by *vchannelID*. The parameter flag is set to one of the following values depending on whether the program has an explicit lock or not.

#define ELOCK_ENABLED   0x01
#define ELOCK_DISABLED   0x02

On success it returns a zero value and non-zero error value otherwise.

SDMSetLockStatus

int SDMSetLockStatus(void* vchannelID, int flag)

This function is called to set or clear the lock on the program available on the Virtual Channel specified by *vchannelID*. When *flag* is set to *ELOCK_ENABLED*, the program is locked and the lock is cleared if *flag* is set to *ELOCK_DISABLED*.

On success it returns a zero value and non-zero error value otherwise.

SDMSetNumSProfiles

int SDMSetNumSProfiles(int numProfiles)

The CApp calls this function to set the number of PDM profiles for which recording space allocation is required. The maximum number of profiles that can be supported is set to a pre-defined number and is known at compile time.

On success it returns a zero value and non-zero error value otherwise.

SDMGetNumSProfiles

int SDMGetNumSProfiles(int *numProfiles)

The CApp calls this function to get the number of PDM profiles currently supported by the SDM for which recording space is allocated.

On success it returns a zero value and set the *numProfiles* parameter to the number of profiles currently supported. A non-zero error value is returned in case of error.

SDMGetSBudget

int SDMGetSBudget(psbudget_t psbudget)

The CApp calls this function to get the current recording space allocated for PDM profiles the currently supported by the SDM. A pointer to an array of structures of type *sbudget_t* is passed in the *psbudget* parameter. This array is allocated in the callers address space and the array size is set to the value that would be returned by *SDMGetNumSProfiles* function if invoked at that time.

On success it returns a zero value and initializes each field of the *sbudget_t* array with the appropriate values. A non-zero error value is returned in case of error.

SDMSetSBudget

int SDMSetSBudget(psbudget_t psbudget)

The CApp calls this function to set the current recording space allocated for PDM profiles the currently supported by the SDM. A pointer to an array of structures of type *sbudget_t* is passed in the *psbudget* parameter. This array is allocated in the callers address space and the array size is set to the value that would be returned by *SDMGetNumSProfiles* function if invoked at that time. The caller initializes all fields of the input array structure.

On success it returns a zero value and accepts all the values specified in the *sbudget_t* array. A non-zero error value is returned in case of error.

SDMInit

*int   SDMInit((void) (*CAppEventNotification)(struct cBackInfo_t *))*

The CApp invokes this functions to initialize the SDM and passes the address of a callback function for event notification as an input parameter. The SDM initializes itself and does other house keeping activities to become operational.

On success it returns a zero value and non-zero error value otherwise.

SDMEventNotification

*void SDMEventNotification(struct sdmCBackInfo_t *))*

This SDM function is called by the DVCR to indicate the completion status of the current DVCR operation. The DVCR passes the address of a completed *sdmCBackInfo_t* structure as input. The SDM is responsible for forwarding these events to other modules (such as the CApp) which request notification of such events.

CApp Filter Type Functions

The CApp controls the SDM filter mechanism by providing filter types. Each filter type is mapped to one or more EPG

parameters. Through these filter types the CApp controls
which EPG parameters will be used by the SDM to determine the
desirability of a program for recording purposes. Every
filter provided by the SDM is mapped to a filter type. When
choosing programs for recording, the SDM scans EPG parameters
based on the available filter types and tries to match these
EPG parameters with the SDM filter data.

The functions provided by the CApp to pass filter type
information are given below.

CAppGetNumFilterTypes

int CAppGetNumFilterTypes(int *cntParams)

This CApp function returns the number of filter types
supported by the Capp.

On success it returns a zero value and non-zero error
value otherwise. On success the input parameter *cntParams* is
set to the number of filters types currently available.

CAppGetFilterTypeID

int CAppGetFilterTypeID(int num, ulong *filterTypeID)

CAppGetFilterTypeID returns the ID associated with a
filter type. The input parameter *num* is an integer between 0
& **N-1** where **N** is the return value of the
CAppGetNumFilterTypes call. The ID returned by this function
is used in all future references to this filter type.

On success it returns a zero value and sets the value of
the *filterTypeID* parameter. It returns a non-zero error value
in case of error.

CAppGetFilterTypeData

int CAppGetFilterTypeData(pfilterType_t ppgmParamData)

CAppGetFilterTypeData returns the filter type data in
the *filterType_t* structure pointed to by the input parameter
ppgmParamData. The caller allocates the *filterType_t*
structure and sets the *filterTypeID* field. The other fields

are initialized by the CApp during the invocation of this function.

On success it returns a zero value and a non-zero error value in case of error.

SDM Filter Functions

The SDM provides filter mechanisms to controls the program content it records. Each filter is uniquely identified by a filter ID and is associated with a specific filter type. The SDM allows modification of the filter parameters based on this filter ID. The number of possible filter types is determined by the Capp.

The functions provided by the SDM that create and control filters are listed below.

SDMGetNumFilters

int SDMGetNumFilters(int *cntFilters)

The CApp calls this routine to determine the number of filters that have been currently created.

On success it returns a zero value and non-zero error value otherwise. On success the input parameter *cntFilters* is set to the number of filters currently created.

SDMGetFilterID

int SDMGetFilterID(int filterNum, ulong *filterID)

This functions is called to get the filter ID. Input to this function is an integer parameter, *filterNUM*, set between 0 and **N-1** where **N** is the return value of *SDMGetNumFilters*. The associated filter ID is returned in the parameter *filterID*.

On success it returns a zero value and non-zero error value otherwise.

SDMGetFilter

int SDMGetFilter(ulong filterID, pfilter_t pFilter)

This function sets the input pointer to point to the information associated with the input filter ID. The caller allocates the *filter_t* structure pointed to by *pFilter*.

On success it returns a zero value and non-zero error value otherwise.

SDMSetFilter

int SDMSetFilter(ulong filterID, pfilter_t pFilter)

This functions is used to set or modify the filter information associated with the filter specified by the input parameter *filterID*. This function is invoked after the caller has initialized or modified the various fields of the filter structure pointed to by the parameter *pFilter*. The fields which can be modified are *filterType*, *filterString*, *maxAllocation* and *desiredAllocation*.

On success it returns a zero value and non-zero error value otherwise.

SDMCreateFilter

*int SDMCreateFilter(ulong *filterID)*

This functions is used to create a new filter. The maximum number of filters that can be created is implementation specific and is set to some predefined upper limit. Calls to *SDMCreateFilter* fails when the number of filters created equals this predefined upper limit.

On success it returns a zero value and non-zero error value otherwise. On success the input parameter *filterID* is set to the filter ID of the newly created filter.

SDMDeleteFilter

int SDMDeleteFilter(ulong filterID)

This function is called to delete the filter associated with the filter ID specified by the input parameter.

On success it returns a zero value and non-zero error value otherwise.

SDM & DVCR Interface

The SDM manages DVCR functionality in a STB through a set of service functions provided by an underlying DVCR library. DVCR requests are passed on by the CApp to the SDM which in turn invokes DVCR functions with the appropriate parameters as necessary. All references to programs in the CApp-SDM interface are in terms of a channel ID whereas in the case of the SDM-DVCR Library interface, programs references are based on filenames. The DVCR library interfaces directly with the underlying file system for performing I/O for file playback and recordation. All functions exported by the DVCR library to the SDM are non-blocking and returns control back to the caller in a fixed period of time irrespective of the duration of the DVCR operation being requested. Any extended monitoring activity that may results from a DVCR request are managed by the DVCR library through background tasks. DVCR library uses a callback function to communicate status and information on incoming DVCR requests and other events. The callback may be invoked within the context of an incoming DVCR request or from some other appropriate context. All information is passed to the SDM through the callback function in the *cBackInfo_t* structure described earlier. The set of functions provided by the DVCR library are given below.

All DVCR operations once started through the DVCR library are expected to continue till an explicit request is made to discontinue the operation. Exception situations (such as BOF and EOF conditions) when the current operation can no longer be continued are indicated to the SDM and higher modules for appropriate resolutions through callback functions. When passing DVCR request to the DVCR library it is the responsibility of the SDM to ensure that the current

DVCR operation is terminated before a new one is initiated. The DVCR state information is maintained by the SDM and is used to direct the correct sequnce of call to the DVCR library.

DVCRStop

ulong DVCRStop(int channelChange)

This function terminates the current ongoing operation (such as rewind, playback, record or fast-forward). It returns an *DVCR_STOP* event and other context dependent information. If the operation that was terminated was a fast-forward or a rewind it indicates displacement in units of the time (in seconds) and sets the *prevEventType* to *DVCR_FAST_FORWARD* or *DVCR_REWIND*. When terminating a playback or record operation, it sets the *prevEventType* field to *DVCR_PLAY* or *DVCR_RECORD* and indicates the duration accordingly. The duration returned is from the preceding playback, record or resume operation till the execution of the current stop operation. The DVCR library also sets the context field in the *cBackInfo_t* structure when terminating a rewind, fast-forward or playback operation in a Virtual Channel. This context is passed as an argument when invoking the DVCR playback function.

DVCR operations may also terminate automatically. Examples are automatic termination due to EOF condition for a fast-forward or playback operation, a BOF (Beginning-Of-File) condition for a rewind condition, lack of storage space during recording etc. Such events are monitored by the DVCR library and are communicated to the SDM through the callback with an *DVCR_IMPLICIT_STOP* event. The duration and context fields of the *cBackInfo_t* structure is set as described for the *DVCRStop* command. It is assumed that the CApp will initiate the succeeding appropriate operation as and when

necessary. Typically in most cases the following operation should be a playback operation.

The *DVCRStop* function is also invoked to stop playback during a channel change from a TSE channel or from a Virtual Channel. Such invocations of the *DVCRStop* function also generate the *DVCR_STOP* event for the SDM and are indicated by passing a TRUE value in the input parameter *channelChange*. The DVCR library may choose to do any housekeeping work, such as closing of files etc., associated with such an event.

On success it returns a zero value and non-zero error value otherwise.

DVCRPause

int DVCRPause(void)

This function pauses the playback or recording operation of the current file and does not affect the fast-forward, rewind or skip operations. It returns a *DVCR_PAUSE* event and sets duration from the preceding play or record operation till the execution of the pause operation. No context information is provided when invoking the callback for this function.

On success it returns a zero value and non-zero error value otherwise.

DVCRResume

int DVCRResume(void)

This function resumes a previously paused playback or recording operation of the current file.

On success it returns a zero value and non-zero error value otherwise.

DVCRFastForward

int DVCRFastForward(ulong privateData)

This function starts a fast-forward operation on the current file. This function accepts the *privateData* parameter

to control the operation of the fast forward request. The *privateData* parameter acts a direct interface between the Capp and the DVCR library and is used to pass information without interpretation by the SDM. Typical usage's for such a parameter include passing the fast forward speed. All fast forward request received by the SDM are forwarded to the DVCR library. It is assumed that the DVCR library can process multiple consecutive fast forward requests and may use these consecutive requests to modify the current fast forward operation if it so desires.

If the current file is associated with a Virtual Channel, the fast forward operation can be carried out till an EOF condition is reached. For TSE Channels, the fast forward operation can be carried on till the end of the circular buffer. This operation can be terminated either on reaching an EOF condition or through an explicit user request to stop the fast-forward operation. *DVCRFastForward* returns a *DVCR_FAST_FORWARD* event if an error occurred otherwise no event is generated. The amount by which the file has been fast forwarded is returned in the callback generated for the *DVCR_STOP* and *DVCR_IMPLICIT* events. In the case when consecutive fast forward request have been made, the callback should return the aggregate amount, in seconds, by which the file has been fast forwarded.

On success it returns a zero value and non-zero error value otherwise.

DVCRRewind

int DVCRRewind(ulong privateData)

DVCRRewind starts a rewind operation on the current file. This function accepts the *privateData* parameter to control the operation of the rewind request. The *privateData* parameter acts a direct interface between the Capp and the

DVCR library and is used to pass information without interpretation by the SDM. Typical usage's for such a parameter include passing the rewind speed. All rewind request received by the SDM are forwarded to the DVCR library. It is assumed that the DVCR library can process multiple consecutive rewind requests and may use these consecutive requests to modify the current rewind operation if it so desires.

If the current file is associated with a Virtual Channel, the rewind operation can be carried out till an BOF condition is reached. For TSE Channels, the rewind operation can be carried on till the beginning of the circular buffer. This operation can be terminated either on reaching an BOF condition or through an explicit user request to stop the rewind operation. *DVCRRewind* returns a *DVCR_REWIND* event if an error occurred otherwise no event is generated. The amount by which the file has been rewound is returned in the callback generated for the *DVCR_STOP* and *DVCR_IMPLICIT* events. In the case when consecutive rewind request have been made, the callback should return the aggregate amount, in seconds, by which the file has been rewound.

On success it returns a zero value and non-zero error value otherwise.

DVCRSkipForward

int DVCRSkipForward(int duration)

This function is invoked to do a skip forward operation on the current file. The amount to be skipped is specified by the input parameter duration in seconds. Unlike a fast-forward operation, skip forward does not display intermediate frames. It returns a *DVCR_SKIP_FORWARD* event and sets the duration field to the amount skipped.

On success it returns a zero value and non-zero error value otherwise.

DVCRSkipBackward

int DVCRSkipBackward(int duration)

This function is invoked to do a skip backward operation on the current file. The amount to be skipped is specified by the input parameter duration in seconds. Unlike a rewind operation, skip backward does not display intermediate frames. It returns a *DVCR_SKIP_BACKWARD* event and sets the duration field to the amount skipped.

On success it returns a zero value and non-zero error value otherwise.

DVCRPlay

*int DVCRPlay(const char *szFileName, int chnltype,*

ulong positionalcontext)

This function is invoked to start the playback operation. The playback operation maybe associated with a channel change operation (ie user tuned into Virtual Channel or a TSE Channel) or maybe due to an explicit playback request generated by the UI.

The *szFileName* parameter specifies the file from which to initiate the playback operation. This parameter is set if the playback is associated with a channel change operation to a Virtual Channel and is set to NULL otherwise. Thus when invoked for a channel change operation from a Virtual Channel to a TSE Channel, or due to an explicit playback request the *szFileName* parameter is set to NULL.

The *chnltype* parameter specifies whether the playback is associated with a TSE Channel or a Virtual Channel. Possible values of *chnltype* are

#define TSE_CHANNEL 0x1

#define VIRTUAL_CHANNEL 0x2

The positional context is used by the DVCR library to determine the location in the file form where the playback operation is to be initiated. This parameter is valid when the *chnltype* is set to VIRTUAL_CHANNEL, and is ignored for TSE Channels. When starting the playback operation for the first time, no positional context is passed (by passing a value of 0). The *DVCRPlay* functions then starts the playback operation from the start of the file. Subsequently when the playback operation is stopped, the *DVCRStop* passes a positional context to the SDM through the callback routine. This positional context is then used in the subsequent playback operation from that file. A positional context is also returned when the rewind and fast-forward operations are completed by the *DVCRStop* commands. *DVCRPlay* returns a *DVCR_PLAY* event if an error occurred otherwise no event is generated.

On success it returns a zero value and non-zero error value otherwise.

DVCRSetTSBuffer

*int DVCRSetTSBuffer(const char *szFileName, time_t size)*

This function is invoked during initialization to specify the name of the file to be used for storing the circular buffer. The size parameter specifies the size of the buffer in seconds.

On success it returns a zero value and non-zero error value otherwise. *DVCRSetTSBuffer* does not generate any event.

DVCRFlushTSBuffer

int DVCRFlushTSBuffer()

This function is invoked by the SDM to flush the current contents of the time shifted buffer associated a TSE channel. This function is typically called when changing channels from a TSE channel to another TSE channel. Thus rewind and

fastforward operations subsequent to a *DVCRFlushTSBuffer* invocation will not access A/V data from the previous channel.

On success it returns a zero value and non-zero error value otherwise. *DVCRFlushTSBuffer* does not generate any event.

DVCRRecord

*int DVCRRecord(const char *szFileName, int recBitRate)*

This function is called to record the incoming audio/video stream onto the file specified by the input parameter. To support recordings at multiple bit rates it accepts the recording bit rate in the *recBitRate* parameter. When *recBitRate* is set to a zero value, the DVCRRecord function uses its own default value. The audio & video streams may be stored in a single file or separate files depending on the DVCR library. The record operation is continued till an EOF condition is reached or through an explicit user request to stop the record operation. *DVCRRecord* returns a *DVCR_RECORD* event if an error occurred otherwise no event is generated.

On success it returns a zero value and non-zero error value otherwise.

DVCRDelete

*int DVCRDelete (const char *szFileName)*

This function is called to delete all the file/files associated with the specified file name passed as an input parameter. If a NULL string is passed as parameter, all non archived files stored by the DVCR library are deleted. (Archived files are referred to above are relevant only for possible future versions of the SDM with archival support). This is used as an error recovery mechanism in the event the

SDM loses information on the current Virtual Channels available.

On success it returns a zero value and non-zero error value otherwise. The delete operation is completed upon return from this call.

DVCRGetFreeSpace

*Int DVCRGetFreeSpace(ulong *numUnits)*

This function returns the amount of free space available in the storage media for recording purposes. The amount of free space available is returned in the input parameter *numUnits*. The unit used to specify available recording space is transparent to SDM.

On success it returns a zero value and non-zero error value otherwise.

DVCRGetSpaceRequired

*int DVCRGetSpaceRequired(ulong *numUnits, time_t duration,*

ulong bitRate)

This function returns the amount of storage space required for a recording operation of a specified duration at a specified *bitrate*. The amount of space required is returned in parameter *numUnits*. The unit used to specify required recording space is transparent to SDM. The recording duration and the recording bit rate are specified in the *duration* and *bitRate* parameters. If a zero value of *bitRate* is specified, the *DVCRGetSpaceRequired* uses its own default value used for recording operations to compute the space required.

It is assumed that the space returned by the above two functions is in terms of the same allocation unit.

On success it returns a zero value and non-zero error value otherwise.

DVCRLive

int DVCRLive(void)

This function is relevant for TSE channels only and is ignored for other channels. *DVCRLive* sets the read pointer associated the circular buffer to the same location as the write pointer. It returns a *DVCR_JUMP_TO_LIVE* event.

On failure, it returns a zero value and non-zero otherwise.

DVCRSetCallback

int DVCRSetCallback ((void)(*SDMEventNotification)

(struct sdmCBackInfo_t *))

The SDM invokes this function during SDM initialization to pass the address of the SDM callback function as an input parameter for event notification.

On success it returns a zero value and non-zero error value otherwise.

DVCRInit

int DVCRInit(void *pDVCRInitInfo))

The *DVCRInit* function is invoked to initialize the DVCR library. The library initializes itself and does other house keeping activities to become operational. The information that is passed in the input parameter *pDVCRInitInfo* is specific to the DVCR library.

It is assumed that this function is called by the CApp before the CApp initializes the MbTV modules. Though not an SDM I/F function, it has been included to specify the order in which this function will be invoked in relation to initialization of the SDM module.

On success it returns a zero value and non-zero error value otherwise.

SDM & PDM Interface

The SDM uses the services of the PDM to determine the user's preference in programs for the purposes of automatic

recording. Automatic recording is initiated when the viewing device is considered to be turned off. The SDM ranks programs based on the user's preference and schedules the most desirable programs for recording. The set of functions provided by the PDM to rank programs based on a user's preference is given below.

MbTVGetProgramRating

*int MbTVGetProgramRating(pgmInfo_t *pgmInfo)*

This function computes the rating of the TV program specified in the *pgmInfo_t* structure pointed to by *pgmInfo*.

The SDM allocates the *pgmInfo_t* structure and sets the *channelID, pgmStartTime* and *pgmTitle* fields in the *pgmInfo_t* structure. Setting of the *pgmDuration* field by the SDM is optional. If the *pgmStartTime* does not match the start time of any program *MbTVGetProgramRating* returns the rating for the program which has the closest start time preceding the specified *pgmStartTime*.

On success it returns a zero value and non-zero error value otherwise.

SDM Virtual Channel EPG Interface

The SDM presents each recorded program to the CApp as a program available on a virtual channel. It maintains EPG data on all these recorded programs and allows access to this data through the set of calls given below.

SDMGetNumChannels

*int SDMGetNumChannels(int *cntVChannel)*

This function returns the number of Virtual Channels created by the SDM. The SDM presents each recorded program in a separate Virtual Channel. The number of channels are returned by the SDM in the *cntVChannel* parameter.

On failure, it returns a zero value and non-zero otherwise.

SDMGetChannelID

int SDMGetChannelID(int vchannelIndex, void vchnlID)*

SDMGetChannelID returns a unique channel Id for the channel number specified by the parameter *vchannelIndex*. The value of *vchannelIndex* ranges from 0 to N-1 where N is the number of channels returned by the *SDMGetNumChannels* call. All future references to the stored program or the Virtual Channel is based on this channel ID returned by *SDMGetChannelID*.

On success it returns a zero value and sets the input paramter *vchnlID* to the channel ID corresponding to *vchannelIndex*. A non-zero error value is returned otherwise.

SDMGetChannelParams

int SDMGetChannelParams(void vchannelID, int paramNum,*
char paramValue)*

This function initializes the buffer pointed to by *paramValue* to Nth parameter of the channel information specific to *vchannelID*. All parameters are returned as NULL terminated C strings irrespective of the native data type of the parameter. This buffer is allocated by the caller and should be of size MBTV_MAX_CHNL_PARAM_SIZE. The value of N is specified in *paramNum*. This function is used when channel parameters are accessed one at a time as opposed to accessing all the channel parameters in a single call. The channel parameter information provided by the SDM for various values of *paramNum* in ascending order are listed as below.

#define   VCHANNEL_ID   1
#define   VCHANNEL_NAME   2
#define   VCHANNEL_OCHID 3
#define   VCHANNEL_TSTAMP   4
#define   VCHANNEL_CRTYPE   5
#define   VCHANNEL_DURATION   6

The semantics of the enumerated channel parameters stored by the SDM for Virtual Channels are as given below.

- the *VCHANNEL_ID* parameter is a numeric parameter of type unsigned long. It returns the Virtual Channel ID for the channel.

- the *VCHANNEL_NAME* parameter is a string parameter and it returns the Virtual Channel name for the channel.

- the *VCHANNEL_OCHID* parameter is a 4 byte *void* pointer and it returns the channel id of the TSE channel from which the program was recorded.

- the *VCHANNEL_TSTAMP* parameter is a 4 byte entity of type *time_t* and it returns the time at which the Virtual Channel was created (the time at which recording for the program was started).

- the *VCHANNEL_CRTYPE* parameter is a 4 byte numeric parameter of type unsigned long and stores information on whether the Virtual Channel was created due to an explicit record request by the user or due to automatic recordation by the SDM. A value of 1 indicates creation due to an explicit record request by the user.

- the *VCHANNEL_DURATION* parameter is a 4 byte numeric parameter and returns the recording duration of the program associated with this Virtual Channel. The recording duration may not be the same as the actual duration of the program.

On success it returns a zero value and non-zero error value otherwise.

SDMGetChannelData

int SDMGetChannelData(void vchannelID, char *vchnlInfo)*

This function initializes the buffer pointed to by *vchnlInfo* with the channel information specific to *vchannelID*. This buffer is allocated by the caller and should be of size MBTV_MAX_CHNL_DATA_SIZE. The channel information

is returned as a C String with each parameter separated by commas. The channel information includes the virtual channel id, the virtual channel name, the channel ID of the live broadcast channel from which this program was recorded, the time stamp for channel creation (which is the same as the program start time), data on whether it was created automatically or at user's request and the actual length of the of the associated recorded program in minutes. This information is passed in ascending order of parameter number.

On success it returns a zero value and sets the input parameter *vchnlInfo* to point to the channel information. A non-zero error value is passed otherwise.

SDMGetProgramInfo

int SDMGetProgramInfo(pgmInfo_t* pgmInfo)

This function returns information on the TV program specified by the *channelID* field in the *pgmInfo* parameter. This function initializes the *pgmTitle* and *pgmDuration* fields of the pgmInfo_t structure, allocated by the caller, and pointed to by *pgmInfo*. All other fields are not modified.

On success it returns a zero value and non-zero error value otherwise.

SDMGetProgramParams

int SDMGetProgramParams(void* vchannelID, int paramNum,
void* paramValue)

This function initializes the *paramValue* buffer, allocated by the caller, to the Nth parameter of the program information corresponding to the channel ID specified by the input parameter. The size of the buffer provided by the caller should be *MBTV_MAX_PGM_PARAM_SIZE*. The information returned here is reproduced from the program parameter information returned for this program by the external EPG library. The information presented therefore is EPG specific.

All EPG specific values, parameters and structures are specified at compile time.

On success it returns a zero value and non-zero error value otherwise.

SDMGetProgramDataBufferSize

int

SDMGetProgramDataBufferSize(void* vchannelID, int* size)

SDMGetProgramDataBufferSize returns the buffer size required to copy the entire program data information for program in the virtual channel specified by the *vchannelID* parameter. The actual format of the structure for passing program information is EPG specific and is transparent to the SDM module but it would contain all the program data information that would be returned by the external EPG library for this program.

On success a 0 value is returned and the input parameter *size* is set to size of the buffer required. A non zero error value is returned in case of failure.

SDMFillProgramDataBuffer

int

SDMFillProgramDataBuffer(void*   vchannelID,   void* pgmData,

　　　　int size)

SPGFillProgramDataBuffer copies the entire program data information into the specified buffer allocated by the caller. The buffer is accessed through the input void pointer *pgmData* and on successful completion of this call contains all program parameters specific to the program in the Virtual Channel *vchannelID*. The size of the buffer is specified by the *size* parameter The program data information that is copied is reproduced from an earlier call to the *EPGFillProgramDataBuffer* for this program. The program data

information passed is EPG specific and is transparent to the SDM module. The external EPG library is used to access the EPG parameters associated with the program data returned by this function.

On success a 0 value is returned and a non zero error value otherwise. An error is returned if the specified buffer size is less than the memory required for copying the program data information.

Event Notification

This section describes the event notification mechanism of the various modules. Each user request generated during a viewing session is processed by the CApp by invoking the relevant function in the appropriate module. DVCR request are passed to the SDM which may forwards them to the DVCR library if required. Commands which originate from the user may thus be trickled down to the SDM and DVCR through the CApp. Status returned by lower level modules in this scenario is communicated back to the CApp through an event notification mechanism. Status for commands that require DVCR support are passed by the DVCR to the SDM which then indicates them to the CApp. As each event is indicated to the CApp, it forwards them on to other modules (such as the PDM) which might require them for monitoring purposes. At each stage of the event notification procedure the event passed to a module maybe remapped to a different event before being indicated further. Details of event notification by each module is described in the following sections.

Event Notification by SDM

The event notification by the SDM to the CApp is through a callback function provided by the CApp. The SDM uses the callback mainly to pass status, indicate events and other information generated as a result of the requests made by the

CApp. Callbacks are made mostly to indicate a start of a DVCR request or the completion of a DVCR request. Event notification by the SDM to the CApp is done only when the request originated from the CApp. Events which result from automatic recordation and deletion operations initiated by the SDM are not indicated to the CApp. The events indicated through the callback are given below.

• The *SDM_REWIND* event to indicate the start of the rewind operation. Information on the duration by which a program has been rewound is available later through a separate stop event.

• The *SDM_FAST_FORWARD* event to indicate the start of the fast forward operation. Information on the duration by which a program has been fast forwarded is available later through a separate stop event.

• The *SDM_STOP* event to indicate the termination of the current DVCR request. Information available through this callback is dependent on the DVCR operation that has been terminated. The callback indicates the operation that has been terminated and specifies the relevant duration of the concluded operation. The stop operation may also be invoked during a channel change operation and such operations are not indicated to the CApp.

• The *SDM_PAUSE* event to indicate pausing of playback or recording on the current channel.

• The *SDM_RESUME* event to indicate resumption of playback or recording on the current channel that was paused.

• The *SDM_PLAY* event to indicate start of playback on the current channel. The playback operation may also be invoked during a channel change operation and such operations are not indicated to the CApp.

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- The *SDM_JUMP_TO_LIVE* event to indicate completion of the **Jump To Live** request.

- The *SDM_ADD_CHANNEL* & *SDM_DELETE_CHANNEL* to indicate addition of a virtual channel or deletion of a virtual channel. Each program that is recorded is associated with a Virtual Channel and the recorded program is considered to be available on that Virtual Channel. Creation and deletion of stored programs are synonymous with program recordation and deletion. The *SDM_ADD_CHANNEL* event is indicated after an *SDM_STOP* has been indicated for the record operation. This indication may be done on completion of recording or when the viewing device transitions to an active state. The *SDM_ADD_CHANNEL* event is indicated only for programs recorded in its entirety.

- The *SDM_IMPLICIT_STOP* event indicates automatic termination of the current DVCR operation. The DVCR operation that may terminate automatically are REWIND due to a BOF condition or a FASTFORWARD or PLAYBACK due an EOF condition or a RECORD due lack of storage resources. On receiving an *SDM_IMPLICIT_STOP* event the CApp may wait for an explicit user request to handle the automatic termination of the current operation or it may initiate its own implicit stop processing. Additionally PLAYBACK, RECORD, REWIND and FASTFORWARD may terminate due to I/O errors.

- The *SDM_SKIP_FORWARD* & *SDM_SKIP_BACKWARD* event indicate the completion of a skip forward or a skip backward operation.

The *SDM_RECORD_ALERT* event is generated when there is an explicit recording request scheduled during an active viewing session. This event is triggered at a predefined interval before the start of the actual recording operation. No other action is taken by the SDM other than providing the alert.

The recording request for which the notification is provided is aborted. The aborted record request can now be executed only through an explicit immediate record request issued by the Capp. The SDM sets the *eventTime and channelID* fields to the start time (in local time) and the channel ID of the program to be recorded.

Details of the event notification function and other CApp support functions required by the SDM are given below

CAppEventNotification

void   CAppEventNotification(struct   cBackInfo_t
*pcBackInfo)

This CApp function is called by the SDM to indicate the start of the current DVCR operation or completion of the previous DVCR operation. The SDM passes the address of a completed *cBackInfo_t* structure as input. The CApp is responsible for forwarding these events to other modules (such as the PDM) which request notification of such events.

CAppChannelChange

int CAppChannelChange(int chnlID)

This CApp function is called by the SDM to change the current channel. The channel being changed to is passed as input.

On success it returns a zero value and generates a channel change event for the other modules (such as the PDM). In case of failure it returns a non-zero error value.

Event Notification by DVCR Library

The set of event notifications indicated by the DVCR is a subset of the events indicated by the SDM. Unlike the SDM notification which indicate both the start and completion of a DVCR operation, the DVCR library notification primarily include completion of DVCR operations. The events generally indicated to the SDM are

- The *DVCR_STOP* event to indicate the termination of the current DVCR request. Information available through this callback is dependent on the DVCR operation that has been terminated. The callback indicates the operation that has been terminated and specifies the relevant duration of the concluded operation.

- The *DVCR_PAUSE* event to indicate pausing of playback or recording on the current channel.

- The *DVCR_JUMP_TO_LIVE* event to indicate completion of the **Jump To Live** request.

- The *DVCR_IMPLICIT_STOP* event to indicate automatic termination of the current DVCR operation. The DVCR operation that may terminate automatically are rewind due to a BOF condition or a fast forward or playback due an EOF condition or a RECORD due lack of storage resources. Additionally playback, record, rewind and fast forward may terminate due to I/O errors.

- The *DVCR_SKIP_FORWARD* & *DVCR_SKIP_BACKWARD* event to indicate the completion of a skip forward or a skip backward operation.

- The *DVCR_REWIND, DVCR_FAST_FORWARD, DVCR_PLAY* and *DVCR_RESUME* events are returned in case of error conditions.

CApp Event Notification

Events communicated by the CApp are typically due to SDM event notifications resulting from servicing user requests. The CApp remaps some of the events indicated by the SDM before they are forwarded to other modules. Details of event notification provided by the CApp are given below.

- *MBTV_POWER_OFF* event is indicated by the CApp when it processes a power off request for the viewing device. Indication of the *MBTV_POWER_OFF* is not mandatory and is usually done by the CApp when it has specific hardware

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support to detect such an event. In most configurations this event will not be indicated by the CApp.

- *MBTV_POWER_ON* event is indicated by the CApp when it processes a power on request for the viewing device. Indication of the *MBTV_POWER_ON* is not mandatory and is usually done by the CApp when it has specific hardware support to detect such an event. In most configurations this event will not be indicated by the CApp.

- *MBTV_REWIND* event is indicated by the CApp when it receives a *SDM_REWIND* event from the SDM. The CApp generates a *MBTV_REWIND* event indication to signal the start of a rewind operation.

- *MBTV_FAST_FORWARD* event is indicated by the CApp when it receives a *SDM_FAST_FORWARD* event from the SDM. The CApp generates a *MBTV_FAST_FORWARD* event indication to signal the start of a fast forward operation.

- *MBTV_PAUSE* event is indicated by the CApp when it receives a *SDM_PAUSE* event from the SDM. The CApp generates a *MBTV_PAUSE* event indication to signal the start pausing playback on the current channel.

- *MBTV_RESUME* event is indicated by the CApp when it receives a *SDM_RESUME* event from the SDM. The CApp generates a *MBTV_RESUME* event indication to signal the resumption playback on the current channel.

- *MBTV_PLAY* event is indicated by the CApp when it receives a *SDM_PLAY* event from the SDM. The CApp generates a *MBTV_PLAY* event indication to signal the start of playback on the Virtual Channel or a TSE Channel in response to a user request for a playback operation. Channel change requests to a Virtual or TSE Channel also result in the CApp invoking the *SDMPlay* function. However no event are indicated by the SDM to CApp in such cases.

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- *MBTV_JUMP_TO_LIVE* event is indicated by the CApp when it receives a *SDM_JUMP_TO_LIVE* event from the SDM. The CApp generates a *MBTV_JUMP_TO_LIVE* event indication to signal the completion of a **Jump To Live** request.

- *MBTV_CHANNEL_CHANGE* event is indicated by the CApp when it completes the channel change operation requested by the user. A channel change operation to or from a Virtual Channel or a TSE Channel may involve the invocation of the *SDMStop* and *SDMPlay* function. In such requests no SDM events are indicated to the CApp except to communicate error conditions. In all such situations, the CApp generates a *MBTV_CHANNEL_CHANGE* as opposed to a *MBTV_STOP* or a *MBTV_PLAY* indication. Channel change operations, initiated by the user or by the SDM for automatic program recordings, are handled independently by the CApp and are always indicated to other modules (such as the PDM).

- *MBTV_ADD_CHANNEL* event is indicated by the CApp when it receives a *SDM_ADD_CHANNEL* event from the SDM. The CApp indicates this event to signal the addition of a Virtual Channel. Each recorded program is presented as being available on a Virtual Channel provided it has been recorded in its entirety. Incomplete recording programs are not presented by the SDM and are automatically deleted.

- *MBTV_DEL_CHANNEL* event is indicated by the CApp when it receives a *SDM_DEL_CHANNEL* event from the SDM. The CApp indicates this event to signal the deletion of a program due to an explicit delete request from a user.

- *MBTV_STOP* event is indicated by the CApp when it receives an *SDM_STOP* event from the SDM. An *SDM_STOP* event is generated due to an explicit stop operation requested by the user. Channel change operations which require the invocation of the *SDMStop* and *SDMPlay* function do not generate a

SDM_STOP event. The *MBTV_STOP* event also provides context dependent information on the operation that has been terminated by the user. The *MBTV_STOP* event is also indicated when it receives an *SDM_IMPLICIT_STOP* due to BOF or EOF conditions on explicit playback, record, rewind and fastforward request.

- *MBTV_ RECORD* event is indicated by the CApp when it receives a *SDM_ RECORD* event from the SDM. The CApp generates a *MBTV_ RECORD* event indication to signal the start of an explicit record request generated by the user for the currently viewed program. Record operations initiated by the SDM for automatic or explicit recording when the viewing device is considered to be inactive are not indicated by the SDM and hence are not indicated by the CApp.

- The *MBTV_SKIP_FORWARD* and *MBTV_SKIP_BACKWARD* events are indicated by the CApp when it receives a *SDM_SKIP_FORWARD* & *SDM_SKIP_BACKWARD* event respectively from the SDM. These events are indicated by the CApp to signal the completion of a skip forward or a skip backward operation.

VSM Interfaces

The VSM interfaces with the SDM and the CApp to determine the status of the viewing device. The SDM uses this information to decide when to initiate automatic recording.

VSM-SDM Interface

The SDM provides a callback function to the VSM for notification on status of the viewing device. The VSM calls this function whenever there is a transition in the viewing status of the viewing device. Details on the function and other functions required for viewing status determination are given below.

SDMViewingStatus

int SDMViewingStatus(int eventType, time_t eventTime)

This SDM function is called by the VSM to indicate a transition in status of the viewing device through the input parameter *eventType*. The time at which the specified event occurred is passed in the parameter *eventTime*. Possible values of *eventType* are

    #define VDEVICE_ON 0x01

    #define VDEVICE_OFF 0x02

    #define VDEVICE_CHECK_STATUS 0x04

The input parameter *eventType* is set to *VDEVICE_ON* when the viewing device status has transitioned from the inactive state to the active state.

The input parameter *eventType* is set to *VDEVICE_OFF* when the viewing device status has transitioned from the active state to the inactive state. The VSM uses this value when it is certain that the viewing status has transitioned to the inactive state. To communicate *VDEVICE_OFF* events, the VSM may rely on available hardware/software mechanism provided by the CApp for monitoring such activity. In the absence of such mechanism the VSM might uses other heuristics to determine an inactive state.

The VDEVICE_CHECK_STATUS value is used when the VSM does not have very high confidence that the a transition to the inactive state has taken place. It is used as a mechanism to alert the SDM of a possible pending *VDEVICE_OFF* event which could occur at the specified *eventTime*. For such events the VSM provides the *VSMStatusCheckRequest* function to the SDM to re-evaluate the viewer device status at any time beyond *eventTime*. The SDM make this callback before it starts any scheduled recording activity.

On success it returns a zero value and non-zero error value otherwise.

    VSMStatusCheckRequest

int VSMStatusCheckRequest(void)

This non blocking VSM function is used by the SDM to request an evaluation of the viewing status. On receiving this call, the VSM schedules an invocation of the SDM callback function *SDMViewingStatus.*

On success it returns a zero value and non-zero error value otherwise.

CApp-VSM Interface

The VSM uses the available services of the CApp to determine viewing status. It provides a callback function to receive status information from the CApp. The CApp communicates all user requests to the VSM first before routing it to the appropriate module for execution. Other request for channel change operations and DVCR requests initiated by the SDM for purposes of automatic recordation and deletion are not indicated to the VSM. Details on the function and other functions required for viewing status determination are given below.

VSMSetViewingStatus

int VSMSetViewingStatus(int eventType, time_t eventTime)

This VSM function is called by the CApp to indicate all user requests generated during a viewing session. The type of events indicated are listed in the section on data structures. Event notification is mandatory for all events with the exception of the *MBTV_POWER_OFF* and *MBTV_POWER_ON* events. If the CApp .is capable the *MBTV_POWER_OFF* event would indicate a transition from the active to inactive state, while a reverse transition would be indicated by a *MBTV_POWER_ON.* In the absence of appropriate support for *MBTV_POWER_OFF* and *MBTV_POWER_ON* events the VSM might uses other heuristics to determine such state. transitions.

Before routing user requests to the SDM, the CApp always invokes *VSMSetViewingStatus* first to indicate the request.

On success it returns a zero value and non-zero error value otherwise.

CAppRequestStatus

int CAppRequestStatus(int *status)

This CApp function is called by the VSM to generate a query in the viewing device to elicit a user response. *CAppRequestStatus* allows for a fixed delay in eliciting a response before it returns a viewing status. A lack of user response is considered to be indicative of an inactive viewing session.

On failure, a non zero error value is returned. On success it returns a zero value and sets the input parameter *status* to a non-zero value to indicate an inactive session. *status* is set to a zero value to indicate an active session.

Features and Implementation Guidelines Overview

The following section discusses examples of how each feature of the preferred system of the present invention can be implemented. The Invocation Screens are intended to illustrate a possible user interface. Customers can implement many other formats. Not all the features are presented with an invocation screen, since many features share the same screen.

Only a sampling of the features available via tuse of the present invention are discussed herein.Thos skilled in the ar will readily understand that many other features are enabled by the present invention.

Features

<u>Getting the Best Programs</u>

Feature Description

Returns a list of top TV programs in a descending order of preference associated with a specific viewer profile. This function automatically determines which profile is currently engaged in viewing a device and generates the best program list for that profile. A different profile will generate a different set of programs for the same time frame.

Invocation Screen

Implementation Guidelines

The CApp invokes the function MbTVGetBestPrograms, which returns the list of programs and takes the necessary steps to display the list to the viewer. The CApp can also scroll forward or back in time, presenting the best programs for a specified profile at a different time, by using the same function with a different time paramete

<u>Getting Criteria Based Best Programs</u>

Feature Description

Provides the same functionality as the feature Getting the Best Programs, except that only programs that match a specified criterion are considered.

Invocation Screen:

See the feature Get Best Programs for a screen of this feature.

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Implementation Guidelines

The CApp calls MbTVGetCBBestPrograms, which returns a list of the programs and takes the necessary steps to display the list to the viewer.

Getting Number of Profiles

Feature Description

Obtains the number of profiles currently supported.

Invocation Screen

Implementation Guidelines

The CApp calls MbTVGetNumProfiles, which returns the number of profiles a device currently supports.

Getting Profile Parameters

Feature Description

Gives the current values of a profile: its name and its status, whether active, frozen, or disabled.

- Active Profile: The SGM allocates space for the preferences of an active profile, and the PDM collects information about the profile so that it can predict and update program information appealing to that profile.

- Frozen Profile: The SGM still considers the preferences of a frozen profile, allocates space, and records programs that will appeal to the profile. But the PDM

does not continue to update and refine the profile's preferences and pass them to the CApp.

- Disabled Profile: The SGM releases space previously allocated to the specified profile.

Implementation Guidelines

The CApp first calls MbTVGetNumProfiles, then the function MbTVGetProfileID, then MbTVGetProfileParams, which returns the parameters of a specified profile, copying the appropriate values from the profile_t data structure.

Setting Profile Parameters

Feature Description

Modifies a profile by changing its name or status. This feature can disable or freeze a profile, as explained in the feature Get Profile Parameters.

Invocation Screen

Setting Profile Parameters is not shown in an invocation screen.

Implementation Guidelines

The CApp calls MbTVSetNumProfiles, then the function MbTVSetProfileId, then MbTVSetProfileParams, which returns the parameters of a specified profile, copying the appropriate values from the profile_t data.

Display Current Profiles

Feature Description

Shows existing profiles by name.

Invocation Screen

See Getting Number of Profiles to see an invocation screen for Display Current Profiles.

Implementation Guidelines

The CApp calls the function MbTVGetNumProfiles. This function calls the function MbTVGetProfileID, which calls MbTVGetProfileParam, which returns one profile name. The

system iterates through the loop for each profile until all the profile names are extracted, and the CApp displays them for the viewer.

Add Profile

Feature Description

Adds one profile to the existing profiles.

Invocation Screen

See Getting Number of Profiles to see an invocation screen for Add Profile.

Implementation Guidelines

The CApp calls MbTVAddProfile, which creates a new profile with a set of predefined defaults, specified in a field of the data structure profile_t (See Section 4.3 of the PDM Interface Specification for this data structure).

The maximum number of profiles that can be created is implementation specific, set to a predefined upper limit. Until that limit is reached, the CApp can create new profiles as appropriate and display them to the user by name.

Notification Requirements

This section describes the event notification mechanism of the various modules. There are two types of events:

- Those that are generated by a specific module

- Those that are forwarded by a specific module

All commands originate from the user, and trickle down to the SDM and DVCR through the CApp. Each user request generated during a viewing session is processed through the CApp. The CApp invokes the relevant function in the appropriate module. DVCR requests are then passed to the SDM, which may forward them to the DVCR library if required.

The status returned by lower level modules in this procedure is communicated back to the CApp through an event notification mechanism. For example, the status for commands

that require DVCR support is passed by the DVCR to the SDM, which then notifies the CApp. As the CApp receives each event it forwards events to other modules (such as the PDM), which might require them for monitoring or storage purposes.

At each stage of the event notification procedure the event passed to a module may be remapped to a different event, or renamed, before it is forwarded.

Details of event notification by each module is described in the following sections.

Events Generated by the DVCR Library

The PDM must know the DVCR status at any point in time. This information is communicated through callbacks. Event notification can be either generated or forwarded. When a function is initiated by DVCR operations, no event notification is necessary. MostDVCR notification events occur when an operation is stopped orpaused, except *DVCR_SKIP_FORWARD* and *DVCR_SKIP_BACKWARD*.

The Controlling Application must be a context of the DVCR sequence. The Controlling Application and DVCR can also implement calls with any context, but they must maintain the sequence of the events.

Unlike the SDM notifications, which notify both the start and completion of a DVCR operation, the DVCR library notifications primarily indicate the completion of DVCR operations. The events initiated from the DVCR to the SDM are communicated through a callback function, provided by the SDM. These events are:

- The *DVCR_STOP* event is generated when the function DVCRStop is invoked. The *DVCR_STOP* event notifies the termination of the current DVCR request. Information available through this callback depends on the DVCR operation that has been terminated. The callback

notifies the operation that has been terminated and
specifies the relevant duration of the concluded
operation.

- Under special circumstances, the DVCR library does not
  generate a *DVCR_STOP*event: whenever the *DVCR_STOP*
  operation is called for a channel change, the DVCR
  library does not generate a stop event.

- The *DVCR_PAUSE* event is generated when the function
  DVCRPause is invoked. The *DVCR_PAUSE* event notifies the
  pausing of playback on the current channel.

- The *DVCR_JUMP_TO_LIVE* event is generated two ways: by
  invoking the function DVCRLive, and by default, when the
  event encounters an End of File (EOF) condition during a
  fast forward operation on a Time Shift Enabled (TSE)
  channel. The *DVCR_JUMP_TO_LIVE* event notifies
  completion of the **Jump To Live** request.

- The *DVCR_IMPLICIT_STOP* event is not associated with a
  DVCR function. It notifies automatic termination of the
  current DVCR operation. The DVCR operations that may
  terminate automatically are REWIND, due to a Beginning
  of File (BOF) condition, FAST FORWARD or PLAYBACK, due
  to an End of File (EOF) condition, or RECORD, due to
  lack of storage resources. These events may also
  terminate due to I/O errors.

- The *SDM_SKIP_FORWARD* event is generated when the
  function DVCRSkipForward is invoked. It notifies the
  completion of a skip forward operation. This operation
  cannot be stopped or paused once it has begun.

- The *SDM_SKIP_BACKWARD* event is generated when the
  function DVCRSkipBackward is invoked. It notifies the
  completion of a skip backward operation. This operation
  cannot be stopped or paused once it has begun.

- The *DVCR_SKIP_BACKWARD* event is generated when the function DVCRSkipBackward is evoked. The *DVCR_SKIP_BACKWARD* event indicates the completion of a skip backward operation. This operation cannot be stopped or paused once it has begun.

- The *DVCR_REWIND* event is generated when the function DVCRRewind is evoked. This event is returned only if an error occurs.

- The *DVCR_FAST_FORWARD* event is generated when the function DVCRFastForward is evoked. This event is returned only if an error occurs. This event is returned only if an error occurs.

- The *DVCR_PLAY* event is generated when the function DVCRPlay is evoked. This event is returned only if an error occurs.

- The *DVCR_RECORD* event is generated when the function DVCRPlay is evoked. This event is returned only if an error occurs.

<u>Events Generated by the SDM Library</u>

Event notification by the SDM to the CApp is through a callback function provided by the CApp. The SDM uses the callback mainly to pass status, notifying the CApp of events and other information generated as a result of requests made by the CApp.

Callbacks are typically made to indicate the start of a DVCR request or the completion of a DVCR request.

Not all recording and deleting operations initiated by the SDM need to be notified to the CApp.

Events generatedby the SDM through the callback function are discussed below.

- The *SDM_REWIND* event is generated when the function SDMRewind is evoked. It notifies the start of the

rewind operation. Information on the duration by which
a program has been rewound is available through a
separate stop event.

- The *SDM_FAST_FORWARD* event is generated when the
  function SDMFastForward is evoked. It notifies the
  start of the fast forward operation. The duration of a
  fast-forward event in a program is available through a
  separate stop event.

- The *SDM_STOP* event is generated when the function
  SDMStop is evoked. It notifies the termination of the
  current DVCR request. Information available through
  this callback is dependent on the DVCR operation that
  has been terminated. The callback notifies the
  operation that has been terminated and specifies the
  relevant duration of the concluded operation. Under
  special circumstances ,i.e. when the function SDMStop is
  called during a channel change operation, the SDM
  library does not generate the *SDM_STOP* event.

- The *SDM_PAUSE* event is generated when the function
  SDMPause is evoked. It notifies the pausing of playback
  on the current channel.

- The *SDM_RESUME* event is generated when the function
  SDMResume is evoked. It notifies that playback on the
  current channel, which was paused, resumes.

- The *SDM_PLAY* event is generated when the function
  SDMPlay is evoked. It notifies the start of playback on
  the current channel. The playback operation may also be
  invoked during a channel change operation, and such
  operations are not indicated to the CApp.

- In special circumstances, i.e. when SDMPlay is called
  during a channel change operation, no event is
  generated.

- The *SDM_JUMP_TO_LIVE* event is generated when the function SDMLive is evoked. It notifies completion of the **Jump To Live** request.

- The *SDM_ADD_CHANNEL* is not associated with any function. It generates the addition of a virtual channel. Each program recorded is associated with a Virtual Channel, and the recorded program is available on that Virtual Channel. The creation of stored programs is synonymous with program recording. The *SDM_ADD_CHANNEL* event is used to notify after an *SDM_STOP* for the recording operation. The *SDM_ADD_CHANNEL* event is notified of programs recorded in their entirety. The *SDM_ADD_CHANNEL* event is generated after the function DVCRStop has been received.

- The *SDM_DELETE_CHANNEL* is not associated with any function. It generates the deletion of a virtual channel. Each program recorded is associated with a Virtual Channel, and the recorded program is available on that Virtual Channel. The deletion of stored programs is synonymous with program deleting. The *SDM_DELETE _CHANNEL* event is used to notify after an *SDM_STOP* for the recording operation.

- The *SDM_DELETE_CHANNEL* event is notified of programs recorded in their entirety. The *SDM_DELETE_CHANNEL* event is generated on returning from the DVCRDelete operation.

<u>Events Forwarded by the SDM</u>

The SDM forwards the events below, usually to map them to its own terminology.

- The *SDM_SKIP_FORWARD* event. is generated when the function DVCRSkipForward is evoked. It notifies the completion of a skip forward operation. The

SDM_SKIP_FORWARD event remaps the *DVCR_SKIP_FORWARD* event.

- The *SDM_SKIP_BACKWARD* event is generated when the function DVCRSkipBackward is evoked. It notifies the completion of a skip backward operation. The *SDM_SKIP_BACKWARD* event remaps the *DVCR_SKIP_BACKWARD* event.

- The *SDM_IMPLICIT_STOP* event is generated when it receives the *DVCR_IMPLICIT_EVENT*. It notifies automatic termination of the current DVCR operation. When the CApp receives the *SDM_IMPLICIT_STOP* event, it can either do nothing and allow the user to recover (by rewinding, for instance), or automatically process the recovery. The *SDM_IMPLICIT_STOP* event remaps the *DVCR_IMPLICIT_STOP* event.

- The *SDM_PAUSE* event remaps the *DVCR_PAUSE* event.

- The *SDM_JUMP_TO_LIVE* event remaps the *DVCR_JUMP_TO_LIVE* event.

- The *SDM_IMPLICIT_STOP* event remaps the *DVCR_IMPLICIT_STOP* event.

- The *SDM_IMPLICIT_STOP* event remaps the *DVCR_IMPLICIT_STOP* event.

- The *SDM_IMPLICIT_STOP* event remaps the *DVCR_IMPLICIT_STOP* event.

- The *SDM_REWIND* event remaps the *DVCR_REWIND* event.

- The *SDM_FAST_FORWARD* event remaps the *DVCR_FAST_FORWARD* event.

- The *SDM_PLAY* event remaps the *DVCR_PLAY* event.

- The *SDM_RECORD* event remaps the *DVCR_RECORD* event.

- The *SDM_RECORD_ALERT* event differs from other events forwarded by the SDM, as discussed in detail in the following sections.

Events Generated by the CApp

Some user actions cause the CApp to generate events, which are processed directly by the CApp.

- The CApp generates the *MBTV_POWER_OFF* event when it processes a power-off request for the viewing device. Indication of the *MBTV_POWER_OFF* is not mandatory, and the CApp usually issues this event only when it has specific hardware support designed to detect such an event.

- The CApp generates the *MBTV_POWER_ON* event when it processes a power-on request for the viewing device. Notification of *MBTV_POWER_ON* is not mandatory and the CApp usually issues it only when it has specific hardware support designed to detect such an event

- The CApp generates the *MBTV_CHANNEL_CHANGE* event when it completes the channel change operation requested by the user. A channel change operation to or from a Virtual Channel or a TSE Channel may invoke the SDMStop and SDMPlay functions. In such requests no SDM events are forwarded to the CApp unless an error occurs. In all such situations, the CApp generates the *MBTV_CHANNEL_CHANGE* event as opposed to *MBTV_STOP* or *MBTV_PLAY* notification. Channel change operations, initiated by the user or by the SDM for automatic program recordings, are handled independently by the CApp and are always notified to other modules (such as the PDM).

Events Forwarded by the CApp

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Events forwarded by the CApp are typically due to SDM event notifications that result from servicing user requests. The CApp remaps some of the events initiated by the SDM before it forwards them to other modules. Details of event notification forwarded by the CApp are given below.

- The CApp forwards the MBTV_REWIND event when it receives the *SDM_REWIND* event from the SDM. The CApp generates the *MBTV_REWIND* event notification to signal the start of a rewind operation.

- The CApp forwards the *MBTV_FAST_FORWARD* event when it receives the *SDM_FAST_FORWARD* event from the SDM. The CApp generates *MBTV_FAST_FORWARD* to signal the start of a fast forward operation.

- The CApp forwards the *MBTV_PAUSE* event when it receives a *SDM_PAUSE* event from the SDM. The CApp generates *MBTV_PAUSE* to signal the start of pausing playback on the current channel.

- The CApp forwards the *MBTV_RESUME* event when it receives a *SDM_RESUME* event from the SDM. The CApp generates *MBTV_RESUME* to signal resuming playback on the current channel.

- The CApp forwards the *MBTV_PLAY* event when it receives the *SDM_PLAY* event from the SDM. The CApp generates *MBTV_PLAY* to signal the start of playback on the Virtual Channel or a Time Shift Enabled (TSE) Channel, in response to a user request for a playback operation. Channel change requests to a Virtual or TSE Channel also cause the CApp to invoke the SDMPlay function. However, no event is sent by the SDM to the CApp in such cases.

- The CApp forwards the *MBTV_JUMP_TO_LIVE* event when it receives the *SDM_JUMP_TO_LIVE* event from the SDM. The

CApp generates *MBTV_JUMP_TO_LIVE* to signal the completion of a viewer's Jump to Live request.

- The CApp forwards the *MBTV_ADD_CHANNEL* event when it receives a *SDM_ADD_CHANNEL* event from the SDM. The CApp notifies this event to signal the addition of a Virtual Channel. Each recorded program is presented as available on a Virtual Channel, provided it has been recorded in its entirety. Incomplete recording programs are not presented by the SDM and are automatically deleted unless otherwise specified by the user.

- The CApp forwards the *MBTV_DEL_CHANNEL* event when it receives a *SDM_DEL_CHANNEL* event from the SDM. The CApp sends this event to signal the deletion of a program due to an explicit delete request from a user.

- The CApp forwards the *MBTV_STOP* event when it receives an *SDM_STOP* event from the SDM. An *SDM_STOP* event is generated by an explicit stop operation requested by the user.

- Channel change operations that require invoking the SDMStop and SDMPlay functions do not generate a *SDM_STOP* event.

- The *MBTV_STOP* event also provides context-dependent information on an operation that has been terminated by the user. The *MBTV_STOP* event is also notified when it receives an *SDM_IMPLICIT_STOP* due to BOF or EOF conditions on explicit playback, record, rewind and fast forward requests.

- The CApp forwards the *MBTV_ RECORD* event when it receives a *SDM_ RECORD* event from the SDM. The CApp generates *MBTV_ RECORD* to signal the start of an explicit record request generated by the user for the program the user is currently viewing. Recording

operations initiated by the SDM for automatic or explicit recording when the viewing device inactive are not notified by the SDM, and hence are not forwarded by the CApp.

- TheCApp forwards the *MBTV_SKIP_FORWARD* event when it receives *SDM_SKIP_FORWARD* from the SDM. It is forwarded by the CApp to signal the completion of a skip forward operation.

- The CApp forwards the *MBTV_SKIP_BACKWARD* event when it receives *SDM_SKIP_BACKWARD* from the SDM. It is forwarded by the CApp to signal the completion of a skip backward operation.

Events Serviced by the CApp

The *SDM_RECORD_ALERT* event is generated when there is an explicit recording request scheduled during an active viewing session. This event is triggered at a predefined interval before the start of the actual recording operation. No other action is taken by the SDM, other than providing the alert. The recording request for which the notification is provided is aborted. The aborted recording request can now be executed only through an explicit immediate record request issued by the CApp. The SDM sets the eventTime and channelID fields to the program start time (in local time) and the channel ID of the program to be recorded.

Events Generated for the VSM

The CApp communicates all user requests to the VSM first, before routing them to the appropriate module for execution. The events forwarded by the CApp to the VSM are as follows.

- The *MBTV_POWER_ON* event is forwarded by the CApp to the VSM to turn power on in the viewing device.

- The *MBTV_POWER_OFF* event is forwarded by the CApp to the VSM to turn power off in the viewing event.

- The *MBTV_VSM_EVENT* is forwarded by the CApp to the VSM for every user interaction except power on and power off.

MbTV User Interface Manager Specifications

This section provides an architectural overview and draft specification for the **User Interface Manager** (UIM).

1. User Interface Manager

User Interface Manager is special MbTV software module which is integrated with CApp
and uses all main components of MbTV (SDM, PDM, EPG library and etc.).

Also User Interface Manager (UIM) employs several special services from CApp such as:

- *Timing Service;*

- *Configuration Service.*

UIM gets a command from remote control and other input devices from user and sends
the stream of *drawing instructions* to **Draw Engine**. Each drawing instruction reflects drawing
the corresponding UI object on a screen. For full redrawing of the screen **Screen Composer** sends the drawing instruction for every objects currently displaying on a screen. For channel
changing Screen Composer sends only a couple drawing instructions for changing colors

on

Controlling application (CApp)

1.1 Main components of UIM

- **Input Device Manager (IDM);**

- **Input Device Drivers (IDD);**

  - *Serial Driver (RS-232);*

        - PC keyboard Driver;

        - USB Driver;

      - IrDA Driver;

- **Object Manager;**

- **Channel Browser;**

- **Screen Composer;**

1.2 Object Manager

During initialization of UI *object manager* creates all UI objects. Each object has

predefined list of views. The main objects which reflect current design of UI are

the following:

chBrowser   -   channel Browser object (for channel navigation);

PreObj   -   preview TV object (for live and recorded TV programs);

TVObj   -   full size TV object (for full screen showing);

AppObj   -   application object (MbTV Weather channel, MbTV News channel and etc.)

SysObj   `- system object (for ads, bars, menus and ets.).

All objects are described by the following structure.

typedef struct _object*List*_

{

    int   *typeObject;*   // type of object

    bool   *visibleObject;*   //
visible/not on a screen;

    bool   *activeObject;*   // active/not
(has a input focus);

```
    objectView_t      *curView;              // current view of
object;
    objectView_t      *listView;             // list of
object view;
    objectList_t      *nextObject;
} objectList_t, *pobjectList _t;
```

```
#define MbTV_UIOBJECT_CHBROWSER              1
#define MbTV_UIOBJECT_PREWND                  2
#define MbTV_UIOBJECT_TVWND                    3
#define MbTV_UIOBJECT_APPWND                  4
#define MbTV_UIOBJECT_SYSWND                  5
```

Each object is placed in preferred area of screen and can be visible or invisible (has a hidden status). The layout of objects on a screen manages by configuration files and depends from user profile. UI objects can be modified by means of configuration files and each object can get focus and can get commands. The focused object get all command from the user.

Some object has a permanent status and some of them temporal status.

Filters is a example of the objects with temporal status.

```
typedef struct  _objectView_
{
    int                          typeView;
// type of view
    objectView_t      *nextView;
// list of object view
    bool                         show;
// show/hide view
```

```c
        objectDesc_t      *objectDesc;
// object description
} objectView_t, *pobjectView_t;
typedef objectDesc_t   void;
```

Each *objectDesc* has different representation depends from the type of object and type of view.

Also *typeView* item depends from category of object. Some types of views for **chBrowser**:

```c
#define MbTV_CBVIEW_NOVIEW        0
#define MbTV_CBVIEW_GRID           1
#define MbTV_CBVIEW_TOPTEN        2
#define MbTV_CBVIEW_STORAGE      3
#define MbTV_CBVIEW_RECORDED    4
#define MbTV_CBVIEW_APPCH          5
#define MbTV_CBVIEW_LATEST         6
#define MbTV_CBVIEW_MOVIE          7
```

1.2.1 Object ChBrowser

Object ChBrowser has a following items:

TimeBar   — current time range for showing channel's program;

ListChannelBars   — channels information list (number or name of channels, program info,

                                    program status);

ProgInfo   — information about current program;

Rating   — rating of program.

Channel Browser supports two modes of browsing channels:

- *time* mode;

- *channel* mode.

In *time* mode **channel browser** shows one or more programs per channel in indicated period of time. In *channel* mode

channel browser shows only specified amount of programs per each channel.

```c
typedef struct _objectBrowser_
{
    chbTimeBar_t        timeBar;                    // time bar
    chbListChs_t        listChs;                    // list of channels
    chbProgInfo_t       progInfo;                   // information about selected program
    int                 tzsec;                      // local time zone in second

                                                    // Difference in seconds between UTC and local time
    int                 type;
#define MbTV_CHBROWSER_TIME             0
#define MbTV_CHBROWSER_CHANNEL          1
    time_t              startTime;                  // start time of showing
    int                 widthTime;                  // width of grid in seconds for showing
    int                 selectedCh;                 // selected channel
    int                 selectedPgm;                // selected program
    int                 chOnTop;                    // channel on top
    int                 totalChs;                   // total number of channels
} objectBrowser_t, *pobjectBrowser_t;
typedef struct _chbTimeBar_
{
```

```
        time_t                      localStartTime;
        time_t                      localEndTime;
        itemRect_t              bar;
// location bar on a screen
        itemColor_t        colorBack;
// background color
        itemColor_t        colorText;
// text color
        itemFont_t         fontText;
// font of text
        itemImage_t        imageNoTV;
// image
        itemText_t         text;
// text of bar
} chbTimeBar_t, *pchbTimeBar;
typedef struct  _chbListChs_
{
        int                     chs;
// number of channels in list channels
        chbCh_t            *fCh;
// ref to first channel
        chbCh_t            *sCh;
//  ref to selected channel
        int                     status;
// status of list channels
        int                     reserved;
} chbListChs_t, *pchbListChs;
typedef struct  _chbCh_
{
        int                     pgms;
// number of programs in channel
```

```c
    itemRect_t            bar;
// location channel bar on a screen
    itemColor_t           normal;
// normal color of the bar
    itemColor_t           selected;
// selected color of the bar
    chbProg_t            *fPgm;
// first program of channel
    chbProg_t            *sPgm;
// current selected program of channel
    chbChName_t       chName;
// name of channel
    int                    chNum;
// number of channel
    int                    chImageID;
// image ID of channel
    void                 *chID;
// channel ID
    int                    status;
    chbBar_t            *next;
// reference to next channel in list
    int                    chType;
} chbCh_t, *pchbCh;
typedef struct  _chbProg_
{
    long                 duration;
// duration of this program
    time_t               startTime;
// start time of this program, read from EPG
    uint                 rating;
// overall rating of this program;
```

```
    char                         *fields[CATEGORIES];        //
epg fields of program
#define CHANNEL_INDEX                              0
#define TITLE_INDEX
1
#define SUBTITLE_INDEX                                 2
#define EPISODE_NAME_INDEX                    3
#define ACTOR_INDEX
4
#define ACTOR_COUNT                                7
#define TITLE_SUB_INDEX                           11
#define DSCR_SUB_INDEX                            12
#define PROGRAM_TYPE_INDEX                13
#define PROGRAM_CATEGORY_INDEX           14
#define COUNTRY_ORIGIN_INDEX             15
#define MPAA_RATING_INDEX                   16
#define QUALITY_INDEX                             17
#define AFFILIATION_INDEX                     18
#define QUALIFIER_FOUR_INDEX             19
    int                      status;
// lock/unlock, live/recorded
#define     RECORD_REQUESTED      0x01
#define     PROGRAM_LOCKED         0x02
#define     LIVE_PROGRAM              0x04
    chbProg_t              *next;
// reference to next program
} chbProg_t, *pchbProg;
typedef struct  _chbProgInfo_
{
    itemRect_t          progInfo;
// location of ProgInfo rect on a screen
```

```
        itemColor_t          colorBack;
// background color
        itemColor_t          colorText;
// text color
        itemColor_t          colorBorder;
// border color
        itemFont_t           fontText;
// font of text
        itemText_t           text;
// prog info text
} chbProgInfo_t, *pchbProgInfo_t;
typedef struct  _chbRating_
{
        int                      imageID;
// image ID of channel
}
typedef struct  _itemRect_
{
        int                   left;           // specifies
the x-coordinate of the upper-left corner of the item
        int                   top;            // specifies the
y-coordinate of the upper-left corner of the item
        int                   right;          // specifies
the x-coordinate of the lower-right corner of the item
        int                   bottom;      // specifies the y-
coordinate of the lower-right corner of the item
} itemRect_t, *pitemRect;
typedef struct  _itemColor_
{
        uint          color;                              //
color (RGB)
} itemColor_t, *pitemColor_t;
```

```
typedef struct    _itemFont_
{
        int             nHeight;
        int             nWidth;
        int             nEscapement;
        int             nOrientation;
        int             nWeight;
        uchar        bItalic;
        uchar        bUnderline;
        uchar        cStrikeOut;
        uchar        nCharSet;
        uchar        nOutPrecision;
        uchar        nClipPrecision;
        uchar        nQuality;
        uchar        nPitchAndFamily;
        char*         lpszFacename;
} itemFont_t, *pitemFont;
typedef  itemText_t  char*;
```

Auxilary structures are introduced for more convenient programing.

```
typedef struct    _chbChName_
{
    char                             name[MAX_NAME_OF_CHANNEL];
} chbChName_t, *pchbChName_t;
```

<u>Some algorithms for **Channel Browser.**</u>

During initialization of channel browser UIM initiates all UI objects and CDM, SDM modules. Using the user profile UIM determines the list of views for each UI object.

CHBInit

```
int

CHBInit()

{
```

```
        // initialize list of views
    for(each available view from user profiles)
    {
            if (current type of view ==  MbTV_CBVIEW_GRID)
            {
                    set objectBrowser.tzsec;
                    set objectBrowser.startTime;
// start time of showing program
                    if (objectBrowser.type ==
MbTV_CHBROWSER_TIME)
                    {
                            set objectBrowser.widthTime;
// width of grid = 1 hour
                    }
                    if (objectBrowser.type ==  MbTV_CHBROWSER_
CHANNEL)
                    {
                            set    objectBrowser.listChs.chs;
// number of showing channel
                    }
                            // initialize timeBar  object
                        chbTimeBar.text = " ";
                        set chbTimeBar.localStartTime;
                        set chbTimeBar.localEndTime =
chbTimeBar.localStartTime +

objectBrowser.widthTime;
                        set chbTimeBar.bar;
// location bar on a screen
                        set chbTimeBar.colorBack;
// background color
```

```
                set chbTimeBar.colorText;
// text color
                set chbTimeBar.fontText;
// font of text
                set chbTimeBar.imageNoTV;
// image
                set chbTimeBar.text;
// text of bar

                    // initialize chbListChs  object
                for (each channel in list channels)
                {
                    set chbCh.bar;
// location channel bar on a screen
                    set chbCh.normal;
// normal color of the channel bar
                    set chbCh.selected;
// selected color of the channel bar
                    set chbCh.chName;
// name of channel
                    set chbCh.chNum;
// number of channel
                    set chbCh.chImageID;
// image ID of channel
                    set chbCh.chID;
// channel ID
                    set chbCh.status;
                    chbLoadPgm_t              loadInfo;
                     loadInfo.startTime =
objectBrowser.startTime;              // start time of
loading
```

```
                          loadInfo.widthTime =
objectBrowser.widthTime;                  // width of grid in
seconds

                          if (objectBrowser.type ==
MbTV_CHBROWSER_TIME)

                          {
                                loadInfo.pgms = 0;
                          }
                          if (objectBrowser.type ==
MbTV_CHBROWSER_ CHANNEL)

                          {
                                loadInfo.pgms =
objectBrowser.showCh;    // number of loading programs
                          }
                          loadInfo.type = objectBrowser.type;
// type of loading

                          loadInfo.chID = chbCh.chID;
// channel ID


                          if (CHBLoadPgmGrid(chbCh.fPgm,
&loadInfo))

                          {
                                SYS_ERR(PANIC, "
CHBLoadPgmGrid(): Loading programs");
                          }
                          chbCh.sPgm = chbCh.fPgm;
// current selected program = first pgm
                    }
              }
              if (current type of view ==  MbTV_CBVIEW_ TOPTEN )
              {
                    chbTimeCh.text = "MbTV Picks at ";
```

```
                        // initialize chbListChs  object
               for (each channel in list channels)
               {
                        set chbCh.bar;
// location channel bar on a screen
                        set chbCh.normal;
// normal color of the channel bar
                        set chbCh.selected;
// selected color of the channel bar
                        set chbCh.chName;
// name of channel
                        set chbCh.chNum;
// number of channel
                        set chbCh.chImageID;
// image ID of channel
                        set chbCh.chID;
// channel ID
                        set chbCh.status;
                        chbLoadPgm_t           loadInfo;
                        loadInfo.startTime =
objectBrowser.startTime;              // start time of
loading
                        loadInfo.widthTime = 0;
                        loadInfo.pgms = 0;
                        loadInfo.type = MbTV_CHBROWSER_ CHANNEL;
                        if (CHBLoadPgmTop(chbCh.fPgm, &loadInfo))
                        {
                            SYS_ERR(PANIC, " CHBLoadPgmTop():
Loading programs");
                        }
                        chbCh.sPgm = chbCh.fPgm;                //
current selected program = first pgm
```

```
                    }
            }
            if (current type of view ==    MbTV_CBVIEW_ STORAGE )
            {
                    chbTimeBar.text = "MbTV   Expected Recorded
Programs  at ";
            }
            if (current type of view ==    MbTV_CBVIEW_ RECORDED )
            {
                    chbTimeBar.text = "MbTV Recorded Programs";
            }
            if (current type of view ==    MbTV_CBVIEW_ LATEST )
            {
                    chbTimeBar.text = "MbTV Latest Programs";
            }
}
typedef struct    _chbLoadPgm_
{
            time_t                         startTime;              //
start time of  program
            int                     widthTime;
// width of grid in seconds
            int                     pgms;
// number of loading programs
            int                     type;
// type of loading
#define MbTV_CHBROWSER_TIME                          0
#define MbTV_CHBROWSER_CHANNEL          1
            void                  *chID;
// channel ID
} chbLoadPgm_t,  *pchbLoadPgm_t;
CHBLoadPgmGrid
```

This function is used for loading all programs of specified channel for grid view.

```
int
CHBLoadPgmGrid(chbProg_t                    *lPgm,
// list of programs

                                  chbLoadPgm_t        *loadInfo)
//  load info
{
        if (loadInfo.type == MbTV_CHBROWSER_ TIME)
        {
        }
        if (loadInfo.type == MbTV_CHBROWSER_ CHANNEL)
        {
            counter = 0;
            while (counter < loadInfo.pgms)
            {
                result = CHBCheckPgmCache(loadInfo.chID,
loadInfo.startTime);
                if (result == SUCCESS)               //  in
cache
                {
                    call Load program from cache;
                }
                else
                {
                    result = CHBLoadPgmToCache(pgm,
loadInfo);
                }
            }
        }
}
```

CHBCheckPgmCache

```
int
CHBCheckPgmCache(void*      chID,                              //
channel ID

                                      time_t     startTime)
// start time of program
{
       if (program in cache)
       {
              return SUCCESS;
       }
       return FAILED;
}
```

CHBLoadPgmToCache

```
int
CHBLoadPgmToCache(chbProg_t                *pgm,
//  program descriptor

                                      chbLoadPgm_t
*loadInfo)                // load info
{
       pgmInfo_t pgmInfo;
       pgmInfo.channelID    = loadInfo->chID;
       pgmInfo.pgmStartTime = loadInfo->startTime;
       pgmInfo.pgmDuration  = 0;
       pgmInfo.pgmRank      = 0;
       pgmInfo.pgmTitle     = NULL;
       pgmInfo.pgmRating    = 0.0;
       pgmInfo.pgmChnlType  = CHANNEL_TYPE_CABLE;
       pgmInfo.pgmFiller    = 0;
       pgmInfo.pgmMark1     = 0;
       pgmInfo.pgmMark2     = 0;
       VOID* pgmData;
       if (EPGGetProgramInfo(&pgmInfo))
```

```
            {
                SYS_ERR(PANIC, " CHBLoadPgmGrid(): Reading date");
            }
            if (pgmInfo.pgmDuration == -1)
            {
                if (loadInfo->startTime < pgmInfo.pgmStartTime)
                {
                    startTime = (loadInfo->startTime/(30 *
ONE_MINUTE))*(30 * ONE_MINUTE);
                    duration  = pgmInfo.pgmStartTime - startTime;
                    char *ch;
                    EPGGetChannelParams(loadInfo->chID,
EPG_CHANNELPARAMS_NAME, &ch);
                    call PutProgramToCache (startTime, duration,
ch);
                    return;
                }
            }
        if (!EPGGetProgramData(&pgmInfo, (CHAR**)&pgmData))
        {
            if (pgmInfo.pgmStartTime > loadInfo->startTime )
            {
                fake = 1;
            }
            else
            {
                strcpy(buf, (char*)pgmData);
            }
        }
        else
        {
            fake = 1;
```

```
        }

    if (fake)
    {
          startTime = (loadInfo->startTime /(30 *
ONE_MINUTE))*(30 * ONE_MINUTE);
          if (pgmInfo.pgmStartTime > loadInfo->startTime)
          {
      duration  = pgmInfo.pgmStartTime - startTime;
          }
          else
          {
                duration = 0;
          }
          char *ch;
          EPGGetChannelParams(channelID,
EPG_CHANNELPARAMS_NAME, &ch);
          call PutProgramToCache (startTime, duration, ch);
          return;
      }
          /* construct start time */
      pos = 0;

        // Step 1 : Read date
      if ((begin = extract(buf, &len, &pos)) < 0)
      {
      SYS_ERR(PANIC, " CHBLoadPgmGrid(): Reading date");
      }
        // Read time
      if ((begin = extract(buf, &len, &pos)) < 0)
      {
      SYS_ERR(PANIC, " CHBLoadPgmGrid(): Reading time");
```

```
        }
        if(EPGGetProgramInfo(&pgmInfo))
        {
            SYS_ERR(PANIC, " CHBLoadPgmGrid(): Reading date");
        }
        startTime = pgmInfo.pgmStartTime;
        if ((begin = extract(buf, &len, &pos)) < 0)
        {
            SYS_ERR(PANIC, " CHBLoadPgmGrid(): Reading
channel");
        }
        call PutProgramToCache (startTime, duration, ch);
        return TRUE;
}
```

CHBLoadPgmTop

```
int
CHBLoadPgmTop (chbProg_t               *lPgm,
// list of programs

                                chbLoadPgm_t        *loadInfo)
//  load info
{
}
```

CHBMoveUp

```
int
CHBMoveUp(chbListChs_t listChs)
{
     if (listChs->sCh == listChs->fCh)           // selected
channel is a first channel already
     {
         call load new channels;
     }
     else
```

```
        {
            set listChs->sCh    to previous channel;
        }
}
```

CHBMoveDown

```
int
CHBMoveDown(chbListChs_t listChs)
{
    if (listChs->sCh == LASTBAR)      // selected channel is
a last channel
        {
            call load new channels;
        }
    else
        {
            set listChs->sCh     to next channel;
        }
}
```

PreObj

This object represents the pre-view window with TV-live (from tuners) or recorded (from DVR) programs. It's possible to have several pre-view windows if hardware allows. UIM supports
multiple **PreObj** object for several tuners or DVRs.

Status   - current status of showing

TVObj

This object has several information items each of them can be hidden.

CurrentTime   - current time on a screen;

ChannelName   - short channel name;

ChannelNumber   - channel number;

InputField   - for remote control input
(channel number or something else);

PlayRecordingTime - actual time from starting program;

RemainingTime   - for TV it's time until the end of
program and for recording program

                                            It's a ending time of
record;

FastMoveBar   - for fast navigation in the recorded
program;

VolumeBar   - volume control;

DVRStatusInfo   - play/recording, pause, FF, rewind,
slow motion, fast motion.

AppObj

    This object looks like a Internet-base technology
applications (MbTV application) written on Java, Html,
JavaScript and used IE controls for informational
representation on Windows CE 2.12 and up or Windows 98
platforms. MbTV applications work in special view-windows by
using multiple IE (Internet·Explorer) ActiveX controls one
for each application. This applications represent special
virtual programs (virtual A-channels) from MbTV Applications
Servers, such as MbTV Weather channel, MbTV News channel,
MbTV Shopping channel and etc.);

SysObj

DateBar   - current date bar;

UserInfo   - current user info (name and etc.);

MenuLock   - menu for locking recorded program;

MenuUnLock   - menu for unlocking recorded program;

MenuRecord   - menu for recording program;

MenuDelRec   - menu for delete record of program;

MenuFilter   - filters

Ads   - advertising window

1.3 Channel Browser

Channel Browser is used for browsing information about channels. *Channel Browser* supports a list of different channel views. Each element of this list represent one of the type of bunching channels (channel grid, top 10, Recorded channels, Application channels, sliding storage and etc.).

```
viewCB_t    *viewListCB;
// list of view
typedef struct _viewCB_
{
    int                 typeView;
// type of view
    viewCB_t        *nextView;
// next view in the list
    chListCB_t      *chList;
//  list of viewing channels
    time_t              timeAt;
//  launching time for timer
} viewCB_t, *pviewCB_t;
```

1.4 UI Draw Engine

UI Draw Engine provides independent level of implementation from the target platform for *drawing instructions* (primitives) for representation MbTV on a user screen (user TV). The stream of *drawing instructions* goes from **Screen Composer** to **Draw Engine**. The stream of *drawing instruction* is prepared by **Screen Composer** according the layout of screen objects and their visibility, screen resolution (NTSC, HDTV) and etc. Draw stream consists from sequence of draw instructions with a code-operation and data for each instruction.

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Functions interface for Draw Engine are also provided.

Some functions of **Draw Engine:**

DEngLoadBitmap

int

DEngLoadBitmap(**BITMAP** bitmap, *int* *imageID)

This function loads specified bitmap to memory and returns bitmap ID.

DEngDrawRect

int

DEngDrawRect(*itemRect_t* rect, *itemColor_t* color)

This function fills specified rectangle with color.

DEngDrawText

int

DEngDrawText(itemText_t *text*, itemRect_t rect, itemFont_t font, itemColor_t color)

This function draws specified text in *rect* location with *font* and *color*.

DEngDrawBitmap

int

DEngDrawBitmap(itemRect_t rect, int imageID)

This function draw bitmap in specified location.

1.5.1 UIChannelUp

int

UIChannelUp(*objectView_t* *view)

```
{
    if(view->selectedCh == 0)
        return;
    if (CAppCheckState(MBTV_CHANNEL_CHANGE))
     return;
    view->selectedCh--;
    view->selectedPgm = 0;
    if(view->selectedCh >= view->chOnTop)
```

```
    {
        if (view->typeView   == MbTV_CBVIEW_GRID   ||
            view->typeView   == MbTV_CBVIEW_TOPTEN ||
            view->typeView   == MbTV_CBVIEW_STORAGE)
            UIDrawChannelGrid(view);
    }
    else
    {
        // Need to scroll down
        view->chOnTop--;
         if (view->typeView   == MbTV_CBVIEW_GRID   ||
            view->typeView   == MbTV_CBVIEW_TOPTEN ||
            view->typeView   == MbTV_CBVIEW_STORAGE)
        {
            UIDrawChannelNames(view);
            UIDrawChannelGrid(view);
        }
    }
    chbCh_t ch = UIGetSelectedCh();
    CAppChannelChange((VOID*)ch->chID, ch->chType,
UIGetClockTime());
    if (view->typeView   == MbTV_CBVIEW_GRID   ||
        view->typeView   == MbTV_CBVIEW_TOPTEN )
    {
        UIDrawVideoBorder(view);
    }
}
```

1.5.2   UIChannelDown

```
int
UIChannelDown(objectView_t *view)
{
```

```
        if ((view->selectedCh +1) >= view->totalChs)        // This
is the last channel
        {
         return;
        }
        if (CAppCheckState(MBTV_CHANNEL_CHANGE))
        {
            return;
        }
        view->selectedCh++;
        view->selectedPgm = 0;
        if (view->selectedCh <= (view->chOnTop + view->chs - 1))
        {
         // No scrolling involved
            if (view->typeView  == MbTV_CBVIEW_GRID ||
                view->typeView  == MbTV_CBVIEW_TOPTEN ||
                 view->typeView  == MbTV_CBVIEW_STORAGE)
            {
                UIDrawChannelGrid();
            }
            else
            {
         // Need to scroll up
                view->chOnTop++;
                if (view->typeView   == MbTV_CBVIEW_GRID   ||
                    view->typeView   == MbTV_CBVIEW_TOPTEN ||
                    view->typeView   == MbTV_CBVIEW_STORAGE)
                {
                UIDrawChannelNames(view);
                UIDrawChannelGrid(view);
                }
            }
```

```
        chbCh_t ch = UIGetSelectedCh();

        CAppChannelChange((VOID*)ch->chID, ch->chType,
UIGetClockTime());

        if (view->typeView  == MbTV_CBVIEW_GRID  ||
            view->typeView  == MbTV_CBVIEW_TOPTEN )
        {
            UIDrawVideoBorder(view);
        }
}
```

1.5.3   UIUpdateView

```
int
UIUpdateView(int typeView)
{
    objectView_t *view = UIGetView(typeView);
    if (view->typeView  == MbTV_CBVIEW_GRID ||
        view->typeView  == MbTV_CBVIEW_TOPTEN ||
        view->typeView  == MbTV_CBVIEW_STORAGE)
    {
        UIDrawChannelGrid();
    }
    if (view->typeView  == MbTV_CBVIEW_GRID  ||
        view->typeView  == MbTV_CBVIEW_TOPTEN )
    {
        UIDrawVideoBorder(view);
    }
}
```

2. Main Features of UIM

The User Interface Manager provides the following set of functionality:

- controlling of **UI** input devices, using unified access to devices by means of *device*

drivers (to **Remote Control** via *Serial*

Driver (RS232), to **PC keyboard** via

Keyboard Driver);

- supporting of UI objects by means of *Object Manager;*

- switching between the objects and perfoming object functionality;

- managing the layout of UI objects and compose the UI screen;

- supporting several TV pre-view windows from several video sources (tuners, DVR);

- supporting MbTV applications;

- auto-tuning remote control devices;

- multilingual interface;

- provides a stream of drawing instructions for drawing on a screen;

2.1 Controlling of input devices

- supports user commands from remote control device used several types of keystrokes;

- down&up keystroke (produce only one command for keystroke after down

or up the key). For example such type of keysrokes used by POWER key;

- press&hold keystroke (produce sequence of command after press and hold

the key). For example such type of keystrokes used by CH LEFT or CH RIGHT

or VOLUME CONTROL keys. Each key employ two parameters: starting delay

and repeating speed.

- provides mapping for remote control keys to MbTV functions;

- supporting different profiles for key's mapping;

3.1 Input Device Manager

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Input Device Manager (IDM) performs the initialization of input device drivers. IDM reads SYS-configuration set and initiates all active MbTV input device drives. IDM creates *Driver Control Block* (DCB) for each device. All DCB are binded in list. All information requests from device drivers can reflect some modification in DCB. IDM supports two conceptions – the *MbTV buttons* and *MbTV keys*. *MbTV buttons* reflects the real buttons of remote control device or PC keyboard.

MbTV keys abstracts the actions (MbTV functions or operations). Special map tables are used for mapping *MbTV buttons* to *MbTV keys*. System for common using and user defined mapping tables exist.

IDM checks the information in each DCB and performs some kind of actions according the button generation rules.

Each input device has unique *Input Device Name* (**IDN**) and *Input Device ID*.

IDM supports the timer interval in 100 msec for detecting of repeating interval.

The maximum amount of repeating sequence of keys is 10 per second.

3.1.2 Driver Control Block

typedef struct _idmDCB_

{

    int   *idID;*
// input device ID

    int   *status;*
// driver status

    int   *btnID;*
// button ID

    int   *keyID;*
// key ID

```
        int               timeCount;
//   counter for timer
        int               btnDelay;
// starting delay of button
        int               btnFreq;
// frequency of button (repeating speed)
        int               btnFlag;
// special for button
        idmDCB_t    *nextDCB;
//   next DCB
} idmDCB_t, *pidmDCB_t;
```

MbTV_VB_UNDEFINED button indicates the waiting state for device. Code of any other button in *btnID* item indicates active input state for device. IDM generates sequence of keys according to rule for each button (frequency of generation) and places them to *KeyBuffer*. *KeyBuffer* is a FIFO data structure (FIFO buffer) which stores the MbTV keys for next processing by **UIM**.

IDM also support several auxiliary data structures for storing button information, mapping and etc.

For processing *KeyBuffer* **UIM** calls *KeyHandler*. *KeyHandler* handles each key on FIFO basis by invoking the corresponding functions.

3.1.3 IDMBtnDown

int

IDMBtnDown(int idID, int btnID)

This function informs IDM about the pressing of button. *IDMBtnDown* returns a 0 value in case of success and a non zero value is returned in case of failure. IdID specifies the device ID and btnID specifies MbTV button ID. IDM checks the current state of device. If driver was in DOWN state before than no any actions takes. In UP state IDM performs

scaning button table and gets the parameters of button (speed, delay and flags).

Also IDM maps button to key and gets key ID for this button. If *btnID* is DOWN/UP button with DOWN producing stage, IDM generates the *MbTV key* for this button. If *btnID* is PRESS/HOLD button, IDM starts to generate the sequence of *MbTV key* according to speed and delay.

3.1.4 IDMBtnUp

int

IDMBtnUp(int idID, int btnID)

This function informs IDM about the releasing of button. *IDMBtnUp* returns a 0 value in case of success and a non zero value is returned in case of failure. IdID specifies the device ID and btnID specifies MbTV button ID. If *btnID* is DOWN/UP button with UP producing stage, IDM generates the MbTV key for this button.

3.1.5 IDMMouseEvent

int

IDMMouseEvent(int event, int x, int y)

```
#define MbTV_MOUSEEVENT_NOEVENT        0
#define MbTV_MOUSEEVENT_LEFTDOWN       1
#define MbTV_MOUSEEVENT_LEFTUP          2
#define MbTV_MOUSEEVENT_RIGHTDOWN     3
#define MbTV_MOUSEEVENT_RIGHTUP         4
```

3.1.6 List of *MbTV buttons*

```
#define MbTV_VB_UNDEFINED      0
#define MbTV_VB_POWER           1
#define MbTV_VB_PLAY             2
#define MbTV_VB_RECORD         3
#define MbTV_VB_STOP             4
#define MbTV_VB_PAUSE            5
#define MbTV_VB_FFORWARD       6
```

```
#define MbTV_VB_REWIND          7
#define MbTV_VB_UP                 8
#define MbTV_VB_DOWN            9
#define MbTV_VB_LEFT              10
#define MbTV_VB_RIGHT            11
#define MbTV_VB_PGUP             12
#define MbTV_VB_PGDOWN       13
#define MbTV_VB_SELECT          14
#define MbTV_VB_DISPLAY        15
#define MbTV_VB_MENU             16
#define MbTV_VB_GUIDE            17
#define MbTV_VB_CLEAR           18
#define MbTV_VB_ENTER           19
#define MbTV_VB_TVPCMODE     20
#define MbTV_VB_VOLUMEUP    21
#define MbTV_VB_VOLUMEDOWN  22
```

3.1.7 List of *MbTV keys*

```
#define MbTV_VK_UNDEFINED     0
#define MbTV_VK_POWER           1
#define MbTV_VK_PLAY              2
#define MbTV_VK_RECORD          3
#define MbTV_VK_STOP              4
#define MbTV_VK_PAUSE            5
#define MbTV_VK_FFORWARD      6
#define MbTV_VK_REWIND          7
#define MbTV_VK_UP                 8
#define MbTV_VK_DOWN            9
#define MbTV_VK_LEFT              10
#define MbTV_VK_RIGHT            11
#define MbTV_VK_PGUP             12
#define MbTV_VK_PGDOWN       13
#define MbTV_VK_SELECT          14
```

```
#define MbTV_VK_DISPLAY          15
#define MbTV_VK_MENU               16
#define MbTV_VK_GUIDE                17
#define MbTV_VK_CLEAR             18
#define MbTV_VK_ENTER             19
#define MbTV_VK_TVPCMODE      20
#define MbTV_VK_VOLUMEUP      21
#define MbTV_VK_VOLUMEDOWN   22
```

4.   MbTV Timing Service

MbTV Timing Service provides several syncronizing functions for different modules of UI on callback basis. Several structures are used for setting and getting timing information from UI modules.

4.1   timerSet_t

This structure is used for setting timer.

```
typedef struct _timerSet_
{
    int         period;
//  launch interval timer with this period
    time_t   timeAt;
//  launching time for timer
    void       callBack(void *timerID);                    //
callback function for timer
} timerSet_t, *ptimerSet_t;
```

Period of timer is set in milliseconds.

4.2   timerInfo_t

```
typedef struct _timerInfo_
{
    int   timeRemain;
    int   countTimer;
} timerInfo_t, *ptimerInfo_t;
```

4.3   TSTimerOnce

```
int
```

TSTimerOnce(void** timerID, ptimerSet *timerSet)

This function sets the timer for using once. *TSTimerOnce* returns a 0 value in case of success and a non zero value is returned in case of failure. In case of success *TSTimerOnce* returns the timer identifier in *timerID*.

4.4   TSTimerAt

```
int
```

TSTimerAt(void** timerID, ptimerSet *timerSet)

This function sets the timer at specific time. *TSTimerAt* returns a 0 value in case of success and a non zero value in a case of failure. In case of success *TSTimerAt* returns the timer identifier in *timerID*. This function uses *timeAt* field for setting time.

4.5   TSTimerStatus

```
int
```

TSTimerStatus(void*timerID, ptimerInfo_t* timerInfo)

TSTimerStatus returns the current status of timer information corresponding to the *timerID* in *timerInfo* structure. *TSTimerStatus* returns a 0 value in case of success and a non zero

value in a case of failure.

4.6   TSTimerStart

```
int
```

TSTimerStart(void** timerID, ptimerSet *timerSet)

This function starts the interval timer with a specific period. *TSTimerStart* returns a 0 value in case of success and a non zero value in a case of failure. In case of success *TSTimerStart* returns the timer identifier in *timerID*.

4.7   TSTimerStop

```
int
```

TSTimerStop(void* timerID)

This function stops the specified interval timer. *TSTimerStart* returns a 0 value in case of success and a non zero value in a case of failure.

5.   MbTV Configuration Service

Configuration Service (CS) supports several different configuration sets:

- system configuration set (for main modules itself);

- UI configuration sets (layout and form for UI objects);

- user profiles configuration sets (special prefered settings for each end users) .

CS uses configuration files for storing values (not the Windows registry for portability).

Values bunching in sections.

Each levels of configuration files have several modes:

- main-mode;

- previous-mode;

- safe-mode;

Main mode uses the current setting of configuration values. In previous mode CS returns the previous value. For each changing of parameters the previous value is stored in a predetermined storage location and can be used in case of request Safe mode supposes to return only default value.

5.1   CSSetMode

int

CSSetMode(int mode)

This function sets the current mode for getting values from CS. *CSSetMode* returns a 0 value in case of success and a non zero value in a case of failure. *Mode* is defined as:

```
#define CS_MAINMODE          0
#define CS_PREVMODE          1
```

#define CS_SAFEMODE   2

5.2   CSGetValueInt

int

*CSGetValueInt(char *set, char *section, char *valuename, int*
*value)

This function returns the specified configuration integer
value from configuration storage.
Set indicates the name of configuration set, *section*
specifies section name of value and *valuename* indicates the
name of value. The configuration value is set in integer
value. CSGetValueInt returns a 0 value in case of success and
a non zero value in a case of failure.

5.3   CSGetValueString

int

*CSGetValueString(char *set, char *section, char *valuename,*
char *value, int size)

This function returns the specified configuration string
value. *Set* indicates the name of
configuration set, *section* specifies section name of value
and *valuename* indicates the name of value. The configuration
value is set in *value* string with a *size* maximum length.
CSGetValueString returns a 0 value in case of success and a
non zero value in a case of failure.

5.4   CSWriteValueInt

int

*CSWriteGetValueInt(char *set, char *section, char *valuename,*
int value)

This function writes the specified configuration integer
value to configuration storage. *Set* indicates the name of

configuration set, *section* specifies the section name of value and *valuename* indicates the name of value. The *value* is written as a integer to configuration storage . *CSWriteValueInt* returns a 0 value in case of success and a non zero value in a case of failure.

5.5   **CSWriteValueString**

int

*CSWriteValueString(char *set, char *section, char *valuename, char *value)*

This function writes the specified configuration string value to configuration storage.

Set indicates the name of configuration set, *section* specifies section name of value and *valuename* indicates the name of value. The configuration value is written as a string to

configuration storage. CSWrite*ValueString* returns a 0 value in case of success and a non zero value in a case of failure.

5.6 **Example of configuration files**

The following is the preferred embodiment of the MBTV main configuration file:

```
; ------------------------------------------------------
; Input Device Manager section [IDM]
; ----
; Installed input device driver
DrvSERIAL = 1
DrvKBD    = 1
; ----
; MbTV buttons:
VK_POWER   = 0
VK_PLAY    = 0
VK_RECORD  = 0
```

```
VK_STOP      = 0
VK_PAUSE     = 0
VK_FFORWARD  = 0
VK_REWIND    = 0
VK_UP        = 2
VK_DOWN      = 2
VK_LEFT      = 2
VK_RIGHT     = 2
VK_PGUP      = 2
VK_PGDOWN    = 2
VK_SELECT    = 0
VK_DISPLAY   = 0
VK_MENU      = 0
VK_GUIDE     = 0
VK_CLEAR     = 0
VK_ENTER     = 0
VK_TVPCMODE  = 0
; ----------------------------------------------------------
; Storage and DVCR Manager
[SDM]
Path = ".\Storage"
; ----------------------------------------------------------
; Preference Determination Module
[PDM]
; ----------------------------------------------------------
; Electronic Program Guide
[EPG]
Path = "P:\ITV\mbtv\Generic\data\MbTVData\epg\FREMONT"
; ----------------------------------------------------------
; Serial Input Device Driver
[Drv-SERIAL]
Device = COM2
```

```
Type    = 1
;   ------------------------------------------------------------
;   PC Keyboard Input Device Driver
[Drv-KBD]
;   ------------------------------------------------------------
;   USB Input Device Driver
[Drv-USB]
;   ------------------------------------------------------------
;   Infrared Input Device Driver
[Drv-IrDA]
;   ------------------------------------------------------------
[IOManager]
Path = ".\Data"
File = "load.bin"
;   ------------------------------------------------------------
;   Debugger
[DBG]
LogFile = ".\Data\MbTV.log"
```

<u>Interface Functions Supported by the UI Modules</u>

I.   For Screen Contexts i.e. Full Screen, Channel Grid,
       Top 10 (MbTVPicks) and Storage List.

The id/pointer to the UI module that is currently active is stored in Context Stack. The top element in the stack will be sent the command to perform the user task requested.

MoveUp

Parameters: None

Called: When the user presses UP key, this function will be called.

Description: In Channel Grid, Top 10 and Storage List, Move to the grid above the current Selection and take necessary actions to repaint screen etc.

MoveDown

Parameters: None

Called: When the user presses the DOWN key, this function will be called.

Description: In Channel Grid, Top 10 and Storage List, Move to the grid below the current Selection and take necessary actions to repaint screen etc.

MoveLeft

Parameters: None

Called: When the user presses the LEFT key, this function will be called.

Description: In Channel Grid, Top 10 and Storage List, Move to the grid to the left of current Selection and take necessary actions to repaint screen etc.

MoveRight

Parameters: None

Called: When the user presses RIGHT key, this function will be called.

Description: In Channel Grid, Top 10 and Storage List, Move to the grid to the right of current Selection and take necessary actions to repaint screen etc.

PageUp

Parameters: None

Called: When the user presses PAGEUP key, this function will be called.

Description: In Channel Grid, Top 10 and Storage List, Move to the grid one page above current Selection and take necessary actions to repaint screen etc.

PageDown

Parameters: None

Called: When the user presses PAGEDOWN key, this function will be called.

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Description: In Channel Grid, Top 10 and Storage List, Move
to the grid one page below current Selection and take
necessary actions to repaint screen etc.

SelectionMenu

Parameters: None

Called: When the user presses ENTER/SELECT key, this
function will be called.

Description: Based on the selected channel type, record or
lock menu is presented to the

user. Context is changed to *SelectionMenu*.

ClearMenu

Parameters: None

Called: When the user presses CLEAR key, this function
will be called.

Description: Present the virtual channel deletion prompt.

Context is changed to *ClearMenu*.

In cases where there is nothing to do (e.g. because the
cursor is already at the end or because it does not apply to
the currently active object) when these functions are called,
the functions return immediately.

The Following Menus are also accessible from the above
contexts:

MainConfigMenu

Parameters: None

Called: When the user presses MAIN_MENU key, this
function will be called.

Description: Present the main menu of the application.

Context is changed to *MainConfigMenu*.

ThemeMenu

Parameters: None

Called: When the user presses THEME_MENU key, this
function will be called.

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Description: Present the Theme search Menu.

        Context is changed to *ThemeMenu*.

LoginMenu

Parameters: None

Called: When the user presses THEME_MENU key, this function will be called.

Description: Present the Toggling Login Menu.

      (When a user is already logged in Logout menu is presented)

      Context is changed to *LoginMenu*.

To allow the user to navigate between the Full Screen, Channel Grid, Top 10 (MbTVPicks) and Storage List, we need enter and exit functions for each of the screens.

SwitchToChannelGrid

SwitchToFullScreen

EnterTop10

ExitTop10

EnterStorageList

ExitStorageList

    II. For Menu Contexts

Once in one of the above menus, the following keys are used to select menu items, set menu item values, allow name editing functionality, present sub menus, clear menus etc.

KeyRight

Parameters: None

Called: When the user presses RIGHT key, in one of the above menus, this function will be called.

Description: Useful for menus with normal values and menus with name editing.

    In case of normal values, the item values are changed accordingly.

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In case of menus with name editing, the position of the cursor is moved to the next editing position or on to the menu item itself.

KeyLeft

Parameters: None

Called: When the user presses LEFT key, in one of the above menus, this function will be called.

Description: Useful for menus with normal values and menus with name editing.

In case of normal values, the item values are changed accordingly.

In case of menus with name editing, the position of the cursor is moved to the next editing position or on to the menu item itself.

NOTE: In case of menus with name editing, when cursor position is on menu item itself (i.e. not in one of the edit locations), keyup and keydown behave as though the menus are normal.

KeyUp

Parameters: None

Called: When the user presses UP key, in one of the above menus, this function will be called.

Description: Useful for all menu items.

In case of normal values, selects the item above the current item.

In case of menus with name editing, cycles to the next value for the position.

KeyDown

Parameters: None

Called: When the user presses DOWN key, in one of the above menus, this function will be called.

Description: Useful for all menu items.

In case of normal values, selects the item below the current item.

In case of menus with name editing, cycles to the previous value for the position.

KeyEnter

Parameters: None

Called: When the user presses Enter/Select key, in one of the above menus, this function will be called.

Description: Useful for all menu items.

Performs action associated with current menu, such as presentation of sub menu or taking user's input and taking appropriate action requested by the user.

Note: In many cases, the menus are cleared when a user presses enter after taking appropriate action. If there are multiple items in the menu all actions are to be taken into account. Also the Menu is popped from the context stack.

KeyEscape

Parameters: None

Called: When the user presses clear/Escape key, in one of the above menus, this function will be called.

Description: Useful for all menu items.

Menu is cleared without taking any action, even if the values were changed etc.

Menu is also popped from the context stack.

Interface functions used by the GUI and CAPP

Recording Conflict Resolution – GUI

If SDMGetNumRecConflicts call returns a false, then there are no conflicts.

If there are conflicts indicated by the above call, Call **SDMGetRecConflicts** for each conflict and format for presentation to the User. These conflicting requests are kept

in temporary memory until the record request is fully
handled.

If the user chooses to override all conflicts, then
SDMSetRecRequest is called for each conflict with the
override flag, until all conflicts are resolved.
Recording Quality - GUI

Structures Used: tdBitRate t

Interface Functions: SDM*TDRBR*

Rewind and Fast Forward speed - CAPP

*All rewind and fast forward requests (when the same operation
is in progress) are propagated down to library functions.
NOTE: Since we currently do not have known speeds, 0 will be
passed for speed.*

Deactivate Learning - GUI

Structures Used: dFilter t

Interface Functions: MbTV*Dfilter*

Premium Channels - GUI

Call the PDM callback function with the following two events:

Structures Used: cBackInfo t

*MBTV ADD CHANNEL and MBTV DELETE CHANNEL with
the appropriate bits set for premium channels.*

Record Date End - GUI

*User Interface will format the date with midnight
time(converted to time t), so that it can be passed in
repeatTill parameter of recRequest t structure.*

Structures Used: recRequest t

PDM Background thread
EMCopy (startTime, EndTime, firstCopy) to copy the External
EPG to internal EPG

Start time is maintained by the PDM background thread.
VMProcessViewingRec(startTime, endTime) to ProcessVRM

PIMComputeProfiles () to ProcessPIM

CDMUpdateDatabase(endtime)

IOCommit (Conditional call, Only if there are changes indicated i.e. any of the bits are set.)

In addition to the above at predefined periodical interval Full Backup needs to be made of all the files. All the bits in the save state are set and IOCommit is called.

PIMComputeProfileMix () needs to be called when the interval specified in the config file passes.

EPG Download - PDM Background thread

OnTimerEvent for the EPGDownload ()

{

    CreateProcess Call with the utility path.

    Reset Time

    Wait for next timer event…

}

Advertising Manager

To facilitate a discussion and understanding of the functionality provided by the Ad Manager, it is helpful to understand the current advertisement process and identify the areas in which improvements can be made.

The Current Advertisement Model

The effectiveness of an advertisement can be attributed to the effectiveness of the following:

Identifying the target segment

This is the process of identifying the segments of population which are more likely to consume the product. This process is typically done by conducting surveys to understand the product consumption of people with various characteristics. The output of this process is an index for each identified category of people. This index quantifies how

much the product consumption of this group different from the general population.

For example, consumption of Coke may be 10 Cokes consumed per day by 1000 people. Consumption of Coke by people between 15 and 25 years of age (category 1) may be 15 Cokes per day by 1000 people. Consumption of Coke by people between 15 and 25 years of age who are earning between 20,000 and 40,000 dollars per year (category 2) may be 20 Cokes per day by 1000 people. In this example the consumption index of category 1 is 150 and consumption index of category 2 is 200. If the same marketing and message strategy is used for all segments and if the effectiveness of the messaging strategy is the same for all category of people, and if the consumption of Coke as opposed to Pepsi can be effected by advertising strategies, Coke can get better use of advertising money by targeting group 2 and group 1 than targeting the general population.

Identifying the target segment involves identifying the people with whom the advertisements will have the most effect. The target segment is represented by a set of parameters which are common to everyone in this segment. Output of this process may be as follows:

Segment id - 1

Parameter 1 - age - between 15-25

Parameter 2 - income - between $20,000 and $40,000

Coverage - 5% of total population (this can be the total number of people in this segment)

Consumption index - 200

Effectiveness Index - 300 (describes the effectiveness of the advertisement strategy on this group)

Segment id - 2

Parameter 1 - gender - male

Parameter 2 - occupation - construction worker

Parameter 3 - age between 25-35

Targeting Advertisement

This is the process of finding the most efficient mechanisms to deliver advertisements to the target segment. The effectiveness of a target delivery scheme can be denoted as the percentage of impressions of the advertisement that are shown to the type of people mentioned in the targeting criteria, or may measured as an index which indicates how much more effective the targeting is in reaching the target segment compared to other mechanisms that do not employ targeting. For example, in the above Coke model, Coke may specify the following as the targeting criteria:

Parameter 1 - gender - male

Parameter 2 - occupation - construction worker

Parameter 3 - age between 25-35.

The Effectiveness of placing a billboard advertisement at a construction site may be denoted as:

Percentage of targeting	- 56% - indicates the percentage of people seeing the advertisement belonging to the target segment.
Targeting Index - 700	- if the percentage of people in the general population is Y (8%) and if the targeting percentage of the ad is X (56) then the Targeting Index is X/Y *100 (700).

Messaging Strategies

Messaging strategies are different techniques used in advertising to ensure that viewers of the ad retain the message in memory and also to encourage viewers to consume

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more of the advertised product. Certain aspects of messaging strategies may benefit from support by the delivery mechanism, such as may be provided by the following parameters:

- Rate of display over a period of time (e.g. number of times an advertisement is shown in a day)
- Period of time between two consecutive displays
- Time of display
- Other display related parameters (display only in the middle of the program, or at the beginning of the program, etc.)
- Ability to buy smaller quantity of impressions
- Ability to specify start and end date for the Ad Campaign
- Ability to subject a target person with a defined sequence of advertisements for a product.

Any new mechanism of ad delivery should have the flexibility of the current delivery medium and also additional flexibility that can improve messaging strategies.

Potentials for new models

Increasing the effectiveness of the above three parameters can increase the effectiveness of an advertisement campaign within a given budget. Identifying the target segment is currently done irrespective of the medium for advertisement. When the target segment is known, the advertisement agencies or the product-marketing group of the company consider different delivery mechanisms. Each delivery mechanism is prioritized based on coverage, effectiveness in targeting, effectiveness in messaging strategy enabled by the medium, and the cost of implementing the campaign. The medium with higher ranking typically is allocated a larger share of the advertisement budget.

If a new advertisement delivery mechanism can increase
the effectiveness of advertisements, the new mechanism can
command a higher CPM (cost per thousands of impression). If
the targeting index can be increased to five times the
current targeting index, advertisers potentially will pay a
price that is between up to five times the original CPM. This
is because the advertisers have to buy only a fifth of the
impressions to reach the same number of people in their
target segment. The CPM would be less than 5 times the
earlier CPM because with the earlier mechanism the advertiser
buys five times the impressions, and because all the
impressions made outside the target segment are not really a
waste due to inaccuracies in identification of target
segments or the need for branding in general beyond target
segments.

Even if the new CPM can be increased to three times the
earlier CPM, the need for buying impressions may go down by a
third because of the effectiveness. This will reduce the
number of impressions bought by various advertisers. The
number of impression available may still remain the same if
the industry is not planning to cut down the number of
advertisements shown to the consumer every hour.

This may cause a surplus of impressions available and a
reduction of demand, accompanied by a consequent reduction in
CPM. A reduction in CPM to 2 - 2.5 times the current rate may
make the medium a very attractive delivery mechanism for
advertisers. This will cause some of the revenues generated
by other media to be diverted to the
broadcast/cable/satellite media. This will fill up the
remaining available impressions and increase the overall
revenues for the Broadcast/Cable/Satellite industry. This
also provides a mechanism for the industry to deal with

advertisement skipping tendencies shown by viewers of advanced PVRs.

Preferred embodiment of the Ad Manager

Model

In a conventional broadcast media, an advertisement is attached to a TV program. People watching the program will see the advertisement if they stay on the same channel when the advertisement is shown. Targeting is done by analyzing the demographics of different programs and choosing the programs that provides the best targeting percentage and coverage.   In a system employing the Ad Manager of the invention, advertisements are de-coupled from programs. Targeting parameters, coverage and messaging parameters are specified for advertisements. Advertisements reach consumer set-top boxes through various delivery mechanisms. These may include sending advertisements on different channels or digital multiplex streams, using different delivery mediums, using different time periods or using the same slots used for conventional advertisements. Advertisements are mixed locally on set-top boxes and are displayed based on parameters attached to advertisements. Advertisements may be displayed during the viewing of programs, during the viewing of the guide, during the viewing of stored programs, during the viewing of other interactive services or during the viewing of the contents of a personal channel. Displaying of all advertisements are controlled by the client component of the Ad Manager (see Fig. 1).   Samples are collected on a set of selected set-top boxes. The samples may contain the following information:

a)   Demographic parameters of viewers of the set-top box

b)   TV watching behavior of viewers of the set-top box

c)   Advertisements displayed by Ad Manager and viewer
responses during the display of advertisements.

The samples are used for creating behavioral profiles of
people with different characteristics. These behavioral
profiles are defined in terms of TV watching behaviors that
can be used to distinguish people of the target
characteristics. This information about different
characteristics and how to identify them using their TV
watching patterns are coded into rules and broadcast from the
head-end to all set-top boxes. Set-top boxes use this
information to compute values of different parameters for
different viewers in a household. The client component of
the Ad Manager may use these computed parameters to decide
which advertisements to store, when to present these stored
advertisements, and when to remove an advertisement from
storage. Viewer sampling also may be used to estimate the
targeting effectiveness of the system.

Functionality and Features

In a preferred embodiment, the Ad Manager would support
or offer, at a minimum, the following functions:

- Ability to specify targeting parameters to
  advertisements
- Ability to measure the targeting effectiveness of
  advertisement
- Ability to report impressions for an advertisement
  and also statistics related to people who watched
  the advertisement
- Ability to specify more defining targeting
  parameters (late sleeper, pizza eater, early
  adapter, single mom etc.)

- Ability to specify conjunctions or disjunctions of different targeting parameters (male and 15-25 year of age, etc)
- Ability to specify messaging parameters (between 10 and 11 p.m., 3 times in a day with 30 minutes interval, only on the middle of a program, when not channel surfing, when watching action programs, etc.)
- Make optimal use of hard disk storage space
- Manage rotation strategies with a set of stored advertisements
- Handle multiplexed advertisements (multiple streams with multiple ads of only one is to be shown)
- Allow blocking of specific advertisements (users can express disinterest to a particular advertisement and the spot will be used up for some other ad)
- Optionally decide when to show an advertisement depending on the business relationship with the network/operator (more advertisements for a particular channel, or more advertisement for a particular type of channel etc., or for some channel the advertisement should be inserted at predefined locations in the middle of the program, for some programs more advertisements should be inserted in the middle of the program rather than at the beginning, for some program the ad rate should increase more towards the end, etc.)
- Ability to mix advertisements on cue or automatically
- Ability to handle multiple profiles in a household with multiple characteristics

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- Ability to force a viewer to watch an advertisement
  by increasing the weight for the advertisement
- Ability to subject a viewer with a defined series
  of advertisements for a particular product.

Architecture

The preferred embodiment of the Ad Manager, as depicted in Fig. 51, comprises four major components:

a)   Ad Server

b)   Targeting Server

c)   Ad mixer

d)   Measuring agent

The Ad Server is the component of the Ad Manager that allows appending targeting parameters to advertisements. The Ad Server provides a GUI for specifying the advertisement for which the parameters are added, the different fields that describe the advertisement, the targeting parameters for the advertisement, the number of impressions for the advertisement, and the messaging parameters for the advertisements. The Ad Server communicates with the Targeting Server to get the targeting parameters and messaging parameters supported by the Ad Manager. The Ad Server generates Meta-data about advertisements that could be processed by the Ad Mixer, and generates data modules and schedules the broadcast times for these data modules. The data modules generated may contain the Meta-data for advertisements in a proprietary format that could be easily processed by PVRs.

In a preferred embodiment, the Ad Server would support or offer, at a minimum, the following functions:

- Provide an easy to use interface to specify ad
  description and parameters with pull down menus and
  auto-completes

- Interface with the Targeting Server to obtain targeting parameters and messaging parameters
- Interface with the Targeting Server to obtain estimated coverage and estimated number of viewers for a given targeting parameter
- Interface with the targeting server to obtain additional characteristics, if any, for the segment defined by the targeting parameters
- Interface with Targeting Server to obtain the targeting efficiency for the targeting parameters specified
- Create meta-data for advertisements based on the targeting parameters
- Create data modules in a transmission format from which meta-data could be easily downloaded without processing information about each ad
- Create broadcast schedules for the data modules
- Maintain information about advertisements for future transmission
- Maintain information about past advertisements for reporting impression statistics.

The Ad Mixer is the component of the Ad Manager that interfaces with the Measuring Agent, and stores and presents advertisements on a PVR. The Ad Mixer downloads rules for computing viewer characteristics, monitors TV viewing behaviors of different persons in the household, and computes target characteristics. The Ad Mixer also downloads Meta-data about advertisements and chooses the most relevant advertisements to store locally, and presents advertisements to viewers according to the targeting parameters specified. The Ad Mixer schedules presentation of advertisements according to the messaging parameters specified, and manages

the mixing of advertisements with AV streams using an API to access platform functionality, including banner advertisements. The Ad Mixer further removes advertisements from storage when the targeting and messaging requirements for the advertisements are completed, when advertisements age beyond predefined thresholds, or when a higher priority advertisement is available to download.

In a preferred embodiment, the Ad Mixer would support or offer, at a minimum, the following functions:

- Manage the presentation of advertisements in a PVR
- Present advertisements meeting targeting and messaging parameters
- Compute targeting characteristics for different viewers in a household
- Manage the storage and deletion of advertisements
- Download and process meta-data for advertisements
- Interface with the Measuring Agent to report parameters about ad presentation, computed parameters, and viewing parameters
- Create a schedule for ad presentation for different channels, programs and types of content
- Implement fair share scheduling techniques to make sure different advertisements with the same targeting parameters are downloaded by different PVRs with the same characteristics
- Implement fair-share scheduling techniques to make sure impression-quantity requirements for advertisements are satisfied
- Manage presentation of AV ads using a platform API
- Handle presentation of advertisements on cue signals from head end
- Handle automatically generated cue signals

- Manage presentation of Graphical (banner) advertisement.
- Manage block (or kill) signals from viewers.

The Measuring Agent is the component of the Ad Manager that communicates with the Targeting Server to report viewer behavior. The Measuring Agent will typically be activated only in a limited set of PVRs, and will preferably interface with the Ad Mixer through a proprietary API, as well as interface with the EPG data library, the SDM, and the PDM. The Measuring Agent will further interface with the CApp to present viewers with a set of questions to provide feedback to the system operator. The Measuring Agent collects the following information about the PVR:

a)   Viewer Characteristics of the viewers

b)   Viewing behavior

c)   Advertisement presentation information

In a preferred embodiment, the Measuring Agent would support or offer, at a minimum, the following functions:

- Interface with the Ad Mixer to collect information about ad presentation
- Interface with the PDM and the SDM to collect information about viewing behavior of viewers
- Interface with the Targeting Server to get targeting parameters and possible values
- Interface with the CApp to query viewers to collect viewer characteristics
- Interfaces with the Targeting Server to report parameters
- Maintain and report queries answered by viewers for accounting purposes.

The Targeting Server is typically operated on the premises of the system operator. The technology employed

would preferably be in a form that requires limited operator input and control. The Targeting Server would typically analyze viewer behavior from the samples collected, and take targeting parameters as inputs to generate rules to identify the target characteristics on set-top boxes and PVRs. The Targeting Server would also estimate the coverage for combination of targeting parameters and also estimate the targeting efficiency. The Targeting Server would typically be able to generate messaging parameters for implementing messaging strategies, as well as report parameters from a previous monitoring interval for various advertisements that were presented during that period.

In a preferred embodiment, the Targeting Server would support or offer, at a minimum, the following functions:

- Interface with the Ad Server to provide targeting parameters available
- Interface with the Ad Server to provide estimated coverage and targeting efficiency for the requested set of targeting parameters
- Interface with a Head-End transmission system to broadcast targeting rules
- Interface with the Ad Server to provide messaging rules for different messaging strategies
- Interface with the Measuring Agent to provide targeting parameters for the Measuring Agent to form queries to be presented to viewers
- Interface with the Measuring Agent to collect reporting parameters
- Generate rules to identify target characteristics
- Generate rules to implement messaging strategies
- Provide a GUI to add new target characteristics
- Provide a GUI to edit rules

- Interface with the Ad Manager to report actual impressions for advertisements for the previous monitoring period.

Implementation Technology

The technological considerations that must be taken into account in developing an Ad Manager that functions effectively include:

- **Ad Server**
  - Defining an interface with the Targeting Server that can be used to transfer required information with minimal interactivity
  - Defining targeting and messaging parameters that will be useful in increasing the effectiveness of targeted advertisement
  - Defining a broadcast data format to transmit meta-data in a form usable by set-top boxes with limited memory, processing and download capability
  - Interfacing with Head-End software to transmit meta-data modules at scheduled periods
  - Handling multiple mechanisms for data transmission and interfacing with Head-Ends with those transmission mechanisms
  - Defining a mechanism to identify advertisements and schedule the transmission of advertisement
  - Defining a mechanism to identify advertisements that are transmitted according to a different schedule that is not managed by the Ad Server
  - Automatically or semi-automatically specifying targeting and messaging parameters to simplify data entry.
- **Ad Mixer**
  - Algorithms for computing values of target characteristics using rules and viewer behaviors

- Mechanism for downloading meta-data for relevant advertisements
- Algorithms to decide what advertisements to download, erase, or keep
- Algorithms to present advertisements in a manner that satisfies targeting requirements, messaging requirements, and other presentation criteria for each of different advertisement presentation schemes
- Mechanism to insert AV Advertisements seamlessly
- Mechanism to insert AV Advertisements on cues from a Head-End
- Mechanism to interface with different hardware platforms to perform ad mixing, ad storage, and ad presentation
- Defining an interface between the Ad Mixer and the Measuring Agent.

- **Measuring Agent**
  - Mechanism to generate queries to be presented to the CApp
  - Defining an API to interface with the CApp
  - Defining APIs to interface with other modules.

- **Targeting Server**
  - Data-mining algorithms for generating rules to identify target parameters
  - Algorithms to compute the efficiencies for different targeting parameters and combination of parameters
  - Algorithms to generate messaging-rules corresponding to messaging parameters
  - Algorithms to estimate coverage for different targeting parameters and combination of parameters.

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A New Advertisement Model

A new Television System model based on recent advances in Digital Television and Computer technology can advantageously replace the traditional TV industry technology and business model of 50+ years standing.

While initially Digital TV seemed to be merely a digital replacement of the analog technology systems (NTSC and PAL), albeit with High Definition picture quality available, now a radically different, new generation TV system model has come to light. This includes much industry-generated technology and standards but is enabled by key advanced technology and architecture by Metabyte Networks Inc (MNI) demonstrating a fully working system.

Digital conversion and compression allow the TV signal to be represented efficiently as digital computer data and stored on a computer Hard Disk Drive (HDD). This together with recent and expected further advances in HDD technology allow a number of hours of video to be saved at the viewers home in a Set Top Box (STB) or Digital Television (DTV) or other device accessible via a Home Network.

The Time-shifting Video Recorder system (PVR), already on sale (eg by TIVO), converts all TV signals to compressed-digital (eg MPEG2) and passes them via a Hard Disk Drive (HDD). All video is then replayed and viewed from the HDD allowing even 'real-time' broadcast video to be paused and restarted or saved for repeat viewing at a later time. PVR concurrent record and replay, a generic capability with HDD storage-effectively a gigantic random access buffer, enables the simultaneous replay of display video stream and recording of new video information (Programs and Ad Commercials) for possible later replay.

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With PVR systems a sophisticated EPG is provided. using specially accessed program metadata (special access sometimes required for the legacy analog case or inadequately developed digital case), to allow the viewer to select a program for view or record. Yet more advanced technology, the Preference Determination Engine (PDE) developed by MNI, addresses the ease of use aspect, automatically providing the viewer with an EPG page of predicted preferred programs called 'Top-ten picks'. The machine-learned preferred programming is also used to drive a PVR automatic recording system. Also, and more importantly, the PDE leads to a demographic profile that enables a new TV commercial system offering improved target advertising called the Ad Manager System (ADMS).

With ADMS the TV commercial (Ad video) is treated separately from Program video (PGM video). The combination of the following technology items allow, in end-user equipment, the broadcast Program and Ad to be identified, saved and later replayed as a channel stream for presentation to the viewer:

- Digital TV broadcast technology (MPEG2) or combination of analog NTSC and digital data (*eg* VBI or Internet data) to give the same effect,

- Intelligent Digital TV end user equipment *ie* including computer and HDD storage (PVR),

- Ad and PGM Video content description metadata and return path metadata, plus identifying mechanism for Program/Ad video transitions, thus enabling video to be treated as information.

The new ADMS TV system is an **-Information Broadcast to Intelligent-TV** based system, very different from the traditional **-Channel Streams Broadcast to Dumb-TV** based system. Because television programming and system running

costs are paid out of advertising revenue it is a critical
issue to demonstrate a workable and desirable new business
model or the new technology cannot be deployed.

A new version of technology for making the viewable
channel broadcast stream currently in equipment racks at TV
company premises, is now implemented in intelligent end-user
equipment for the local creation of a TV channel (Program and
Ad) Stream called 'Personal TV'. Intelligent End-User
Equipment (EUE) is a STB, DTV converged with a PC *ie* having
file system and hard disk type high capacity (10+ GigaBytes)
non-volatile storage.

The new system is 'Personal' because for some or all
advertising time slots, program time slots, or channels the
presented video is no longer the stream broadcast to and
viewed by millions. It is wholly or partly derived locally
from video information sent previously, that is either
broadcast at off-peak times or overnight or via alternative
means *eg* the Internet. Additional to Ad video, Ad
information is alternatively sent as data and converted to
graphics or banner in the end user equipment for overlay on
EPG's or applications.

Metabyte Networks Inc. augments the aforementioned
technology with TV program viewing and behavior monitoring
and analysis and automatic profiling that is easier to use by
predicting program selection preferences (top ten picks EPG)
for the predicted current viewer or viewing group, called
Preference Determination Engine (PDE). This is made
automatic because the majority of TV viewers cannot be
expected to manually login and enter their profile and
program preferences to enable system operation.

The PDE profile or profiles are converted to viewer
demographic profiles using ADMS derived parameters or rules

and allow advertisements with a target demographic to target by matching the active viewer profile at the EUE. The conversion parameters or rules are derived directly, by using login data input to a representative sample set of EUE systems, or indirectly from commercially available program-ratings data eg from Nielsen -also sampled input data. ADMS targeting done automatically in each intelligent EUE, is totally different to the traditional model where Nielsen program-ratings value and target by Ad attachment to a program of the broadcast channel stream at the TV Studio or Distribution facility.

ADMS targets viewers individually and using the more reliable demographic from a history of two or more weeks of viewing compared to the traditional broadcast model of Ad attachment to an attractor program. Ad-to-program attachment provides successful targeting for certain programs that do target well and mainly for the majority demographic audience percentage but not for the remainder.

With ADMS, transmission of the Ad is now not coupled to the showing or presentation of the Ad. Repeat showings or impressions are made from storage rather than wasting transmission bandwidth by repeatedly sending the same video information. Gained transmission time (plus off-peak or overnight time) is used to send additional different Ad's to be used for better targeted Ad slot time presentation commanding a higher $ value.

It is a key factor for the business model that the concurrent presentation by ADMS, of a number of different, suitably targeted Ad's, has more aggregate value thus increasing the overall Ad revenue of the TV system.

To maximize the chance that a targetable Ad is available for selection at the client end-user equipment there is a

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large degree of oversupply of Ad's broadcast by the ADMS operator and some degree of oversupply of Ad's captured and saved by each EUE. Unlike the traditional business model where Ad presentation is guaranteed and only audience estimated, with ADMS both the Ad presentation is estimated and audience is estimated. ADMS return path sampling directly coupled to the targeting parameters etc allows a desired Ad campaign result to be achieved by closed loop automatic adjustment of target or messaging parameters. Thus there is more reliance on return path sample based estimation which must include more information (eg specifically about the Ad's) and new business models are therefore required to reflect the change.

It is clear from the fact that there is some degree of Ad oversupply that there is some degree of competition for the target advertising slots. In the EUE, the ADMS software effectively performs an automatic auction for the available Ad slots by looking at the Ad target parameters (Ad metadata, see Section 4) comparing against the user (or user group) profile generated locally to decide what to show. One of the parameters can be money offered per impression (per other parameters) allowing the system to choose which is the most valuable, profitable and targetable Ad to show. Clearly the operation of the combination of Ad metadata and EUE ADMS software has a valuable on-going part to play for the industry and business models reflect that by assuming that a portion of on-going Ad revenue is taken by the ADMS operator.

An additional requirement factor for the new system technology and business model is that it should support and co-exist with the traditional TV advertising model which realistically is expected to survive for a long time, if not indefinitely. Of key interest is how the ADMS system

operator can get reward for the improved TV advertising system introduced.

Aside from the immediate stated advantages for targeting Ad video commercials the PDE automatic program preference and profiling used for making the 'Top-ten picks' EPG is also used for automatically saving program video of predicted user interest. This is effectively targeted advertising for forthcoming TV programs.

The viewer is able to pre-select and prioritize, if required, from the 'Top-ten picks' EPG, those pre-recorded programs that he wishes to be strung together to form a personal TV channel stream for viewing. The resultant channel contains mainly programs targeted to the preference of the viewer and where the viewer fits the typical majority demographic (in-demographic) for the program also contain Ad's mainly targeted to the viewer. Some programs eg News are best real-time live and have less value if stale, so the viewer will sometimes tune live broadcast and away from the personal channel. Overall the experience of the viewer is improved.

Personal TV channel is a new type of TV channel controlled by the ADMS business operator. It is clear that the originator of the video program owns Ad slots within and between their sourced programs whether live or from HD storage. The ADMS operator has rightful claim for a portion of the Ad slot time $ value proceeds for periods where the ADMS targeting has improved the overall value of the time.

While technically more demanding (time synchronization and scheduling reasons) to use live programs not fully stored on the EUE HD the business model is the same whether stored or live programs are used to make the presented channel stream. In both cases the TV Company sourcing the program

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has the right to control the Ad slots within the program including repeated showing.

ADMS is the first complete and working industry example and business model description for the **Information Broadcast to intelligent TV** system, a revolutionary, next-generation TV system.

ADMS Improvements to Traditional TV Ad Targeting

This section shows how the PDE and the AD Manager eliminate the large sections of mis-targeted Ad's inherent with today's TV commercials system.

The section points out that the program preference profiling by the PDE, producing the top-ten preferred program list, is doing a first level of Ad targeting -this fact is exploited further, but without the AD Manager System full Ad targeting is not achieved. For the PDR system two different systems cases are considered and compared below, Live Ad Substitution and Ad Insertion/Substitution into Preferred Programs played from Storage.

Not highlighted in the description here is the fact that there are additional general improvements included with ADMS based on the fact that the sample data collected has more points than that used today by the industry (eg Nielsen), see Section 5.5, Advanced knowledge discovery techniques to generate information that enhances and complements the sample data collected.

ADMS makes a general overall improvement to Ad demographic targeting accuracy. However, it remains to be seen whether showing a Gillette Shaving Ad instead of an M&M Candy Ad to a adult male watching the Scooby Doo' cartoon, while demographically better, produces a better final result for the advertiser, i.e. higher sales volume.

Live Ad substitution.

Based of industry viewer sampling some programs don't provide a strong demographic target profile and others provide a main profile but not all viewers that watch and like the program fit within it. Also, the live program schedule cannot cater to all demographics in every time slot so there are many times when a person is viewing out-of-demographic because there is nothing else to watch at that time.

Individually in each EUE box, ADMS identifies those programs where the live broadcast Ad doesn't target its intended viewer demographic and substitutes a targeted Ad from its HD cache store. The showing of multiple different individually targeted Ad's improves the aggregate targeting for the whole population of viewers per each Ad slot time. ADMS targeting recognizes and targets Ad's at these times.

The following diagram, Table 1, shows total viewers for a given time. The right-hand portion of viewers dislike or are indifferent to the program and are watching because it is live TV and there is nothing else to watch at this time. This has a large proportion of viewers not in the normal demographic for the program (eg Adult male watching Sabrina). The left hand side is of viewers that like the program and mainly fit in the normal main demographic but there are still some that do not fit.

ADMS determines the viewers not in-demographic at this time and replaces their Ad's with targeted ones based on other programs viewed and other behavior. The extent of the ADMS improvement, relative to traditional TV advertising, is the marked blue shaded boxes of diagram.

Table 1

TOTAL VIEWERS AT CERTAIN TIME SLOT			
LIKE the PROGRAM		DISLIKE OR are INDIFFERENT to the PROGRAM eg Viewing because there is nothing else to view	
IN-DEMOGRAPHIC	NOT-IN DEMOGRAPHIC	IN-DEMOGRAPHIC	NOT-IN DEMOGRAPHIC

Two examples show ADMS targeting improvement for all programs of the traditional system, those that demographic surveying says are watched by a very broad array of the population and thus traditionally cannot target well and those watched by a narrow demographic and thus do target well.

(1)   If the PDE system learns that that Sabrina and similar programs are watched often, and excluding other information, AD Manager will determine that there is a teenage girl profile present. Then it can use that information to select teenage girl Ad's even when Wheel of Fortune (or other program attracting a broad spectrum demographic) is being viewed.

(2)   ADMS improves aggregate targeting for programs that do target well. For example when Sabrina is being viewed it can determine that the viewer is not from the expected teenage girl target and can select an Ad more suitable based on preference learned over time.

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Ad insertion/substitution into Preferred Programs played from Storage

This case is different from the Live Ad Substitution case because the programs are entirely viewer-preferred and pre-selected by the PDE so all viewers like their programs. Another point is that the case is similar because it is most likely that the program was captured from a broadcast already segmented with Ad's so this is effectively another case of Ad substitution.

Referring to the diagram below, Table 2, and comparing to the case above, and Table 1, the viewers that do not like the presented program are no longer present and viewers that like their program (many different programs to suit each taste) replace those viewers. Because those viewers better target their program this changes the work done by the AD Manager. While the overall targeting effect is the same the PDE, by pre-selecting liked programs for everyone, has improved some of the Ad targeting already and left a little less for the AD Manager to do. ADMS improves the marked blue shaded boxes of diagram and there is less in this diagram than the above diagram for the live Ad substitution case.

Table 2

TOTAL VIEWERS AT CERTAIN TIME SLOT			
VIEWERS that LIKE theirPROGRAM (PDE selected pre-recorded preferred program)			
IN-DEMOGRAPHIC	NOT-IN DEMOGRAPHIC	IN-DEMOGRAPHIC	NOT-IN DEMOGRAPHIC

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Prior work

Prior work by the TV and technology industry has laid the groundwork for the new information based TV system, however, on it's own has not been enough to complete the picture and invent the new information based TV system (ADMS).

Some of the existing standards and their understood scopes follow:

- MPEG and MPEG2 defines the digital encoding and digital broadcast stream composition.

- MPEG4 standard sets to treat video and audio as objects that can be manipulated by the viewer to produce alternative views and sounds of scenes -producing a type of personal TV which the viewer can interact with.

- The MPEG7 standard (also related standards work in SMPTE and ATSC sets to define metadata that identifies and describes programs segments and their contents (actors, theme etc).

- The TV-Anytime forum (TVA), an offshoot from DAVIC, sets to standardize items necessary for the Personal Video Recorder (PVR) including a targeted advertising. The PVR is a computer with large hard disk drive unit performing the functions of STB, DTV, or PCTV types of End-User Equipment (EUE). At this time documents up to ANxxx, WDzzz and TVyyy are published. Although the potential for targeted advertising is mentioned in some TVA documents system description and business model is not included. Indeed new technical detili and system work by Metabyte Networks Inc. in this and other documents are to be contributed to TVA.

Metabyte believes the complete and working information based TV system (ADMS) has not been described before because

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the above standards, while certainly contributing, are insufficient to enable it.

Further items are required and are provided only by Metabyte technology:-

- (1) Automatic determination of users program preferences -EUE resident,

- (2) Automatic profiling mechanism (to automatically determine the user or using group)- also EUE resident,

- (3) Mechanism for profiles (2) preferences (1) to be represented as demographics -also EUE resident,

- (4) A feedback mechanism to enable a Nielsen like programs and commercials TV-Ratings function for a significant sample of EUE units. Partly an EUE and partly a ADMS operator Headquarters based system.

- (5) A business model to enable paid commercials and improved Targeted Advertising, on the new system, allowing all players that contribute to the TV system to make money ie the TV Companies, Program producers and owners, ADMS inventor and operator (if different).

-

New Business Models Enabled by ADMS.

Scope

There are 3 business model development stages to consider:

- (1) The traditional business model for TV advertising where viewers only have traditional TV equipment capable of viewing a ready made broadcast channel stream only;

- • (2) The new AD Manager System (ADMS) with targeted advertising business models assuming everyone has the new technology capable of creating a personal channel stream from cached video and the traditional model is no longer in operation. This may be the situation in 10 or more year's time;

- • (3) Extended interim period where some viewers still have traditional equipment (1) and some have new ADMS capable equipment (2). This may be the case for up to 10 years or even may be the prevailing case.

New Business Models.

General

It is a simple fact that the new targeted advertising business cannot operate until there are a significant number of systems deployed in EUE. In order for the introduction of ADMS to proceed at the maximum possible rate it is sensible to offer the technology to system operators and EUE manufacturers at the lowest possible charge.

The automatic preference determination agent PDE is given for little or no monetary charge to manufacturers to enhance the capability of their EUE by a locally generated 'top-ten predicted program picks' EPG. This visibly enhances their ELJE capability, for a signed agreement that the full set of ADMS software, enabling personal channel program stream creation and Ad targeting, is also deployed and that MNI has an agreed on-going financial interest in the business it enables.

A key driver in the business model is to sell the superior TV program Ratings Data service provided by ADMS technology, where the Ratings charges are refunded (to

prevent abuse ie use for a third purpose) as Ad's are successfully placed. This is superior because the AMDS EUE sample systems collect more data.

Key factors examined in the business models are:

(1) ADMS viewer profile targeted Ad video from insertion to presentation.

(2) Payment for Ad by advertiser and settlement of payments to TV company and ADMS operator.

(3) Payment for ADMS derived TV-Ratings and targeting information (eg Nielsen type),

(4) Operation of ADMS within today's TV system broadcast channels.

The above is to do with the receiving payment for advertising impressions. Another aspect of the business model is to do with the more valuable responses to the impressions. Viewer's interest in an Ad is inferred by a Click response for previously supplied Ad ancillary information which is requested and displayed. Click response is a higher value than an Impression and S value is assessed from Clicks made by the sample population. The ancillary information is text or image converted to graphics window or banner for overlay.

Targeted Program Video

While the descriptions and business models are written for targeted advertising of Ad video they also apply to any type of video. Entertainment, Movie or News program video may also be targeted to viewers based on past program preferences or demographics or other sampled personal information.

Similar to the described ADMS Ad video system, using 240 transmission time an oversupply of Program video may be

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entered, eg using the World Wide Web, with a loose (not tight) control at the TV distribution facility and then broadcast. ADMS EUE selects and stores from the oversupply of programs based on learnt preferences. At the convenience of the user some programs are viewed. Representative sample return path information is used to report program video viewing statistics allowing determination as to whether a particular program was viewed sufficiently or other success measure.

The determination is then made as to whether to allocate future valuable transmission bandwidth for further similar programs, types, genre etc. This closed loop operation can be automated allowing the TV production/distribution company or independent companies without a broadcast transmission franchise to submit programs and receive payment eg based on viewership of inserted AD's.

If a program producer eg PBS or BBC does not wish the presentation of their program to be interrupted to show (targeted) Ad's then the Ad metadata can set to indicate it be permitted (eg for free). For some concerns permission is granted only if remuneration, eg to replace license fee, subscription or donation, is assessed and collected by other means eg pre-purchased, pre-paid, pre-subscribed card deduction using smart card technology or a telephone type pre-paid card eg purchased at the local supermarket. As the program presents, an amount is deducted from the pre-paid card. When the pre-paid amount runs out then the Ad's will be shown if program is allowed in this case.

Details to support this are in the metadata section 4. Use of pre-paid card protects the security of the viewer, as the EUE only has capability to read and limited write capability only to deduct money amounts from the card.

Certain material eg movie, is encrypted to prevent illegal copying. A smart card can be used in this case to decrypt the video signal as well as perform the payment function.

Operational and Business Model (1)

This operation and business model is characterized by:

•   Ad targeting to individual viewer or group demographics, perceived product interest and other parameters,

•   Competition between similarly targeted Ad's for presentation time,

•   Monitoring a statistical representative sample of the ADMS EUE population,

•   Ad payment settlement after the monitoring period determined level of Ad campaign success, based on at least demographic targeting success, with ADMS operator receiving a percentage payment,

•   Targeting performance improved by learning and upgrades downloaded to EUE.

Figure 52 depicts the diagram of the operational flow and business model (1) for the AD Manager System.

On the right of the diagram is the client or End-user Equipment (EUE) showing blocks of relevant functions: Rules, Profiles and User and Ad Target demographics, Controls, EUE Display and Store. On the left are blocks for the Advertisers, the Advertising companies (eg Ford, Coca-Cola) and the Ad Agency that operates with the ADMS system. At lower middle is the TV company distribution facility and head-end equipment operating part of ADMS, and upper middle is the ADMS operator Headquarters. Throughout it is assumed

ADMS operator is referred to and may or may not be the same company as the ADMS system maker.

The Fig. 52 operational flow is marked by the text paragraph numbers starting with number 1, top right. Some of the paths have a higher number also. This is because the operation loops and so a second (higher) number refers to second time around the loop. So to follow the flow, start with 1, then 2, then 3, incrementing up until 14. Some of the numbers also have alpha characters eg 14a, 14b, 14c. This refers to a point of the flow where a number of related things are simultaneously done (or nearly so) and it makes more sense to give them the same number.

The EUE contains Display, Video Program and Ad Storage and Control for Display (Presentation) and Store. User program viewing profile information (Profile block) together with conversion parameters (Rules block) make the User Demographic Characteristic block of information, the viewer demographic profile and target. The Ad demographic information arrives before or with the Ad to show the targeted User demographic and is saved in the 'Ad Demographic Target Characteristic' block as shown.

The man on the right is the viewer and operates the EUE at loop (#1) to the Profile. Over time his program preference profile is learnt using machine learning techniques. If the algorithm detects the appearance of more than one viewer then the profile divides into 2 or more profiles (2 are shown). Where there is consistently group viewing then the profile is that for group preferences. The preference engine relies on Electronic Program/Content Guide (EPG/ECG) program metadata ie descriptive data about the programs their category and genre. This may be accessed

overnight specially, see path #1a or for ADMS supported MPEG2
streams the data is broadcast, see #1b.

Additional control data with normal program EPG/ECG
metadata includes schedules for when and on what TV channel
or other conduit the additional Ad video and metadata is to
be sent. This is updated as required by the AD Manager
operator via the TV distribution loop, for example along with
necessary parameters (see Rules on figures). It is expected
that future technology will at minimal cost allow EUE with
extra tuner/decoders for internal use to allow ADMS to
collect Program and Ad video and metadata. automatically at
any time without the constraint of only having access out of
viewer hours. Preferably one known (out-of-band) channel is
dedicated to this use and available on all broadcast TV
systems (ATSC, Cable, Satellite etc).

The final EUE block is for audience measurement a
possible function of all EUE, but only deployed in the small
percentage forming the representative sample. For those
customers requiring a guarantee that private preference
information cannot in some way leave their EUE, privacy is
set at manufacture and cannot be altered by software upgrade,
tampering or by operational mistake. On the other hand other
non-concerned users purchase or otherwise receive special EUE
that enables return path sampling and are contacted and
registered and perhaps offered incentives to allow their data
to be collected.

For measurement (#2) one should assume that there are
millions of EUE systems. Mostly viewers don't want their
private information collected and analyzed and in fact it is
unnecessary and expensive to collect data from 10's millions
of viewer EUE. Sampling a representative number of EUE (eg
tens of thousands) is satisfactory for predicting data for a

population (eg of millions of units) to a level of accuracy
sufficient for most concerns.

As the ADMS system boots-up, data collected by ADMS-HQ,
path #2, is ADMS automatic profiling information or preferred
programs and genre's, audience measurements and ratings of
viewer numbers but demographic information is also required
to enable demographic based targeting. Demographic data is
either collected directly from the ADMS sample boxes using
data from personal questions to the viewer(s) at login (path
#1) and subsequently when there has been a change of viewer
(path #11) or obtained indirectly from standard industry
sampling eg Nielsen where this is done.

At ADMGR-HQ the data is analyzed and conversion
parameters (rules), to transform ADMS profile data to
demographic form data, are produced from the sample (#2)
data. The rules based on input sample data (#2) are extended
to the whole population of EUE and are downloaded (#3)
allowing all boxes to have a target demographic profile. The
next step (#4) is to solicit advertising.

As an inducement to advertisers the AMDS superior
ratings service and/or knowledge base is made available (#4b)
after refundable payment is received (#4a)—refund on Ad
submission. This encourages companies to place Ad's rather
than just use the ratings service. The body functioning as
Ad agency sets dollar value for the number of impressions per
demographic targets and then solicits Ad's, path #5.

Ad's are submitted to the system ('AD Server'), see path
#6, with desired targeting information, messaging
requirements and pre-payment for examination and conversion
by the ADMS agency to standard form ADMS metadata, see
Section 4. An oversupply of Ad's are submitted in a
relatively unmarshaled fashion at the upper end of the system

and compete with each other for presentation down at the client EUE part of ADMS. Because presentation is not guaranteed, the billing of pre-approved credit customers is delayed or payment is held in escrow until the end of the monitoring period when the Ad campaign results are available.

Ad placement, contract, targeting and messaging information (Ad metadata) may be in a standardized Web form suitable for direct insertion into ADMS. One example of the principle of using the XML Web technology for automatic system entry is from the Web industry and developed mainly for Web use and not yet developed for TV or ADMS TV. It is given by 'adxml.org', see XML document definition DTD's: 'TVAdPlacement' and 'TVAdContractData' in Appendix A.

The Ad agency submits (via 'AD Server') Ad's and accompanying Ad metadata to one or more television distribution company systems operating ADMS, paths #7a and #7b, which may be a TV network, or system provider eg Terrestrial, Cable or Satellite. The metadata is modified and supplemented with information about the channel. program or other determined presentation restrictions see metadata Section 4. Ad metadata already in ADMS standardized metadata form may be passed directly to the television system. XML parsers and document definitions (DTD's) can check the submissions for accuracy and omissions. The actual Ad's (eg video) themselves maybe submitted a variety of ways eg MPEG2 based Ad's may be submitted by a direct on-line method (Internet).

The television system distribution facility, or head-end, broadcasts the Ad (video and/or graphics) and control Ad metadata, see #8. This is could be broadcast as MPEG2 digital data with the ATSC, Satellite or Cable system, or analog video and VBI digital metadata on the legacy NTSC

analog system. Alternatively the Ad could be sent digitally via automatically dialed direct telephone hook-up or an Internet connection. The Ad carries identification to be able to link it to the corresponding Metadata allowing them to be sent separately if the system permits it.

For the foreseeable future television systems must support the traditional program channel stream model shown at #8. Therefore additional ADMS video must be sent during the night outside of scheduled program time. All channels per region are assigned time for this. At first use or initialization time a user must be asked for the ZIP code of the region the system is operating in. The system makes a direct dial connection (800 number) or Internet if available, to an ADMS HQ information server to obtain set-up information for that region including scheduled time(s) for each channel for broadcast of the ADMS targeted Ad's.

The ADMS controlling server ('AD Scheduler') at the television distribution head-end of the designated channel operates a schedule to make sure sufficient Ad's are broadcast to enable targeting and that the metadata is sent before or with the video. This allows the EUE system software ('AD Mixer') to examine the Ad metadata and decide whether a particular Ad video is worth saving to HD storage for possible later use or not, see path #9. The Ad must be clearly identifiable by the television sysstem marking the Program/Ad transitions.

Later, depending on channel, program being viewed and predicted viewer a targeted Ad is selected and shown. Rules downloaded (broadcast or sent at overnight dial-up time or Internet), see #3, are used to convert the learnt viewer preference profile(s) into a viewer demographic profile. It is this profile that is targeted by the Ad. EUE algorithm

software ('AD Mixer') compares the target demographic and viewer demographic and if compatible selects the Ad for presentation see #10a. Other information can be used to select one Ad in favor of another eg $ per impression. Also although most of the description is geared towards demographic based targeting the Ad metadata can indicate choice of other targeting parameters eg program interest (like the old traditional model), product category interest, large group viewership eg large homes or bars, etc.

In the EUE, ADMS prepares and presents the new TV channel stream of Programs and Ad's for the viewer, see #10b. This is typically made entirely from recently pre-recorded programs and ADMS targeted Ad's. While technically harder particularly from a synchronization point of view it is possible to use live program material with some or all ADMS Ad substitutes. Business-wise there is no difference between the two, all programs are played from the HD storage with some delayed by seconds or fractions thereof and some delayed by hours or days.

As the viewer watches the pre-prepared program stream the automatic preference engine also watches to see if the selected programs are indeed of interest. Skipping programs, cutting out program segments or cutting programs short and fast forwarding, indications of incorrect selection or changed preference, cause further learning and modification of the profiles, path 11. For the sample boxes only change in viewer demographics is also input at step #11 and can be input at anytime.

In addition at step #11, as the viewer watches the pre-prepared channel stream, Ad campaign success is monitored and saved by the EUE ADMS. This includes recording the identity of those Ads selected from the broadcast stream and stored,

and of those Ad's the ones that were presented and those not presented and remain or were deleted. Response to Ad's is particularly valuable information. Ad preference and behavior determined by whether the Ad was re-viewed (2nd —multiple impression) and whether ancillary data was requested (reported as the more valuable 'click') is also recorded. Ad information is also used locally to in future augment demographic based Ad targeting by enabling selection of similar Ad's and Ad's of similar products etc.

All Program and Ad recorded data is collected from ADMS sample EUE boxes, at the end of the designated sampling period, path #12. Data includes viewer or viewing group program preference profiles, viewing behavior and demographics and also includes the all recorded data for Ad's as described above.

ADMS headquarters collates data collected from the sample and extends it to cover the whole population of EUE boxes, see #13. The result is used to generate downloads to improve system operation in the light of learned behavior and allow payment settlement. The business uses settlement-by-result because at the time of submission Ad impression is estimated but not guaranteed.

Downloads are of conversion data and algorithm improvements to the TV company server and majority population of EUE boxes step #3, including improving the conversion rules to go from program preferences to demographics and the Ad targeting algorithms.

Payment settlement is for Ad's broadcast during the previous monitoring period. This includes #14a: refunding (for escrow payment) or billing (for credit customer) the Advertising company, #14b: making TV company payment and #14c: making ADMS operator payment.

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Operational and Business Model (2)

This operation and business model is characterized by:

- Ad targeting to individual viewer or group demographics, perceived product interest and other parameters,

- Competition between similarly targeted Ad's for presentation time,

- Monitoring a statistical sample of the ADMS EUE population

- Ad slot time purchased wholesale from the TV Company by the ADMS operator. Payment settlement after the monitoring period determined level of Ad campaign success, based on at least demographic targeting success, with ADMS operator receiving the difference between the Ad company charge (less any refund) and the wholesale price paid.

- Targeting performance improved by learning and upgrades downloaded to EUE.

This business model is based on an ADMS operator middleman operation for suitable Television Ad time. Certain TV Ad presentation slot time is purchased wholesale from the TV Network company and used for ADMS targeted advertising. This is done for slot time that is determined able to be targeted effectively by ADMS and more so than by the simple program attraction. The TV Company is able to maintain control by only marking the Ad/Program transitions for those Ad's which AMDS is permitted to substitute.

The ADMS operator effectively takes on the risk that the system out-performs the existing TV advertising system where performance is measured by demographic targeting by eliminating the untargeted blue shaded areas of Table 2. As an inducement to the TV Company the wholesale Ad-slot price can be slightly higher than normally obtained.

This business model allows ADMS to be slowly brought up alongside today's broadcast channel system and where first one slot time is sold to ADMS for a trial and then more and more slot times are allocated for ADMS use.

Figure 53 illustrates the diagram of the operational flow and business model (2) for the AD Manager System. The system technical operation (mostly on the right) and description above is similar to Figure I but the business model and position of AD Manager System Operator mostly on the left differs.

The ADMS operator takes on the Ad agency and slot-time wholesale function. Now the advertisers don't need to pay for or see the TV Ratings (Nielsen) data. They place Ad's direct to ADMS, #6, paying the dollars per demographic impression and giving additional messaging requirements (preferred presentation times, dates, prohibited programs, channels etc) and leave it to ADMS to meet or exceed the impression count to satisfy the order.

ADMS then purchase the necessary Ad slot time from the Television Company, one or more TV channels etc to meet the demand, #7c, subsequently submitting the Ad video #7a and metadata #7b. From now on until 13 the system works as figure 1, business model 1.

At step 13 the program TV rating and ADMS extended audience measurements are used internally to ADMS HQ for measuring the Ad performance. There is no need to sell or publish the results apart from for auditing purposes. At step 14 a settlement is required if the Ad failed to meet the impression and other targets paid for to refund the Advertiser.

METADATA

EPG/ECG METADATA

Electronic Program Guide and Electronic Content Guide Metadata. Program Guide is the program name channel and time. Content Guide is additional information about the program eg type, genre. The more information available about each program the better the job the preference determination engine (PDE) can do in determining a viewers preferences and predicting liked programs.

This is standard information required by most types of EUE system and is in fact being developed by a number of standards groups (eg MPEG7, TVA-WD173). All video should have this metadata including ADMS Ad video.

Example Program content descriptions of programs. Including:

PROGRAM

    ID

    TITLE

    ACTORS

    TYPE

    GENRE

    CONTENT CATEGORY PERCENTAGE (violence 25%)

    etc

ADMS CONTROL/SCHEDULING METADATA

ADMS requires this information to be able to tune to, scan and record the targeted material, ie Ad video, Ad metadata and other video and metadata, from the broadcast TV channels that are distributing it. If the Internet is used then the Web address URL is given. Telco 800 number access is used to provide control/scheduling metadata -especially useful as a default mechanism should other communications fail.

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Example:

BROADCAST SCHEDULE for Targeted Material:

    CHANNEL 42-1, TIME 0100-0300

    CHANNEL 7-2, TIME 0300-0400

INTERNET ACCESS for Targeted Material

    WWW, mbtc.com/schedule/123xyz789abc

TELCO ACCESS

    800-123-4567

    etc

Ad TARGETING METADATA

Ad Targeting metadata is required for each the Ad video segment. The information allows ADMS operating in the EUE to select Ad video for targeting it's perceived viewer profile. All video could have this metadata but certainly ADMS Ad video requires it.

Ad ID: (Global UPID, Content Reference ID)

Ad RIGHTS: (Copyright Owner ID, TV Distribution Owner ID, Ad Targeting Operator ID etc)

Ad TYPE: List (Banner, Video, Banner or Video)

Ad ENVELOPE INFO: (Metadata Encryption ID, Video Encryption ID)

Ad TARGET DETAILS:

DEMO-Graphic-1 Information Target: List (Race, Language, Sex, Household income, Age group, Education, Occupation, Geographical information)

DEMO-Graphic-2 Information Target: List: (Presence of kids in house, Hours of TV watching, Time of TV watching, Habitual Channel Surfer, Active responders that click for data)

PROGRAM Target List: (Program1, Program2..n)
GENRE of Program Target List: (Football fan, Movie lover,

See Genre classification schemes (EBU's Escort2.4 CS and NHK's Genre CS).

PROGRAM-OFF Prohibited Target List: (Program1, Program2..n)

GENRE-OFF of Program Prohibited Target List: (Football fan, Movie lover, See Genre classification schemes (EBU's Escort2.4 CS and NHK's Genre CS).

PRODUCT Target List: (SIC**1, SIC**2..n)

PRODUCT-OFF Prohibited Target List: (SIC**1, SIC**2..n)

PROFILE of Program Preferences Target List: (Param1, Param2..n)

PROFILE-OFF of Program Preferences Prohibited Target List: (Param1, Param2..n)

OTHER Target List: (Item 1, Item2..n)

OTHER-OFF Prohibited Target List: (Item 1, Item2..n)

Note:

For additional information about PRODUCT and OTHER see section 5.

Ad TARGETING LOGIC:

NO-AD-INSERTION-(FREE, PRE-PAID(billing-rate-info, security code: abcxyz, money-out-no   Program, money-out-show-AD))

NO-AD-SUBSTITUTION

NO-TARGET

TARGET-1 (DEMO-1, DEMO-2, PROGRAM, GENRE, PROGRAM-OFF, GENRE-OFF, PRODUCT, PRODUCT-OFF, PROFILE, PROFILE-OFF, OTHER, OTHER-OFF)

TARGET-2 (DEMO-1, DEMO-2, PROGRAM, GENRE, PROGRAM-OFF, GENRE-OFF, PRODUCT, PRODUCT-OFF, PROFILE, PROFILE-OFF, OTHER, OTHER-OFF)

TARGET-(3...n)

LOGIC OPERATORS (OR, AND, XOR)

EXAMPLES OF TARGET_FORMULA:

TARGET_ FORMULA (NO-AD-INSERTION-0231mn, abc789))

TARGET_ FORMULA (NO_TARGET)

TARGET_ FORMULA (TARGET-1 AND TARGET-2 OR TARGET-3 etc ...)

Ad MESSAGING DETAILS:

CAMPAIGN DATES, Start and End Dates: (Start Date, End Date).

PAYMENT $ per Impression for Time Range: ($, Day of week, Time start., Time   end), ($, Day of week, Time start, Time end).

IMPRESSIONS, Maximum Number of: (Total, Per Day, Per Program).

PRESENTATION, Preferred Time Range: (1, Day of week, Time start., Time end),

(2..n, Day of week, Time start, Time end).

POSITION Preferred within Program: (Beg, 1/8, ¼, 3/8, ½, 5/8, ¾, 7/8, End).

INTERVAL of Time Between two consecutive Presentations: (Time).

RETURN PATH METADATA -from Minority Sampled Systems

DEMOGRAPHIC-1 Profile. Information detail: (Age, etc see above lists),

PROGRAMS-1 Viewed by Profile 1, Programs viewed (ID List...)

PROGRAMS_SKIPPED-1 Viewed by Profile 1, Programs viewed (ID List...)

PROGRAM SEQUENCE-1 Viewed by Profile 1, Programs viewed (ID List...)

BEHAVIOR_SURFING-1 Parameters (Detail List)

BEHAVIOR_TIME-OF-DAY-1 Predominant Parameters (Detail List)

BEHAVIOR_AD-SKIPPING-1 Use Characteristic (Ad Type, Detail

List, ….)

BEHAVIOR_FFWD-FREV-1 Use Characteristic Parameters (Detail
List)

BEHAVIOR_SURFING-1 Parameters (Detail List)

AD_RESPONSES-1 Positive eg Click's for Information List
(ID, ….)

A D-1 Presented to Profile 1, List: (ID, time/date 1.
response 1, time/date 2, response 2 etc ...), (ID,
time/date 1, response 1, time/date 2, response 2 etc ...),
(ID, time/date 1, response 1, time/date 2, response 2 etc
...), etc. etc.

ABOVE DATA REPEATED FOR PROFILES 2 .... n

Enhancements over Regular ADMS

*Advanced knowledge discovery techniques to generate
information that enhances and complements the sample data
collected*

System where Ad preferences select further targeted Ad's

Description

Extra Ad video content descriptive metadata (together
with accumulated viewer behavior reactions to Ad video if
enabled) help data obtained from program video preferences,
to predict and guide future targeted advertising.

The AD manager data-mining engine (DME) employs advanced
knowledge discovery techniques to generate information that
enhances and complements the sample data collected. In its
simplest form, the DME system learns relationships between
the behavioral models (b-models) created by the multi-user
profiling system, the empirical viewer demographic data, and
customer supplied Ad information. The user b-models are

created by machine learning and pattern recognition methods
to capture key viewing patterns and preferences that not only
tend to identify individual users, but additionally serve to
relate and identify substantially interesting advertisements
and programming. This capability enables a way to increase
consumer Ad targeting that is very different from existing
methods, and complements the Ad to Program learning paradigm
set forth above.

The DME, through the user's b-model, uses empirical data
and Ad identifiers as high confidence knowledge points to
grow a network of inferred relationships that connects
otherwise unrelated Ad's and programming to a viewers
preferences and viewing behavior. Each Ad from the Ad server
is tagged with descriptive information including duration,
demographic targeting, and Standard Industry Codes (SIC)
[such as those found at] or some similar categorical system.
The SIC serves a similar function as genre codes in EPG data.
Over time, the learning system associates patterns of
advertisement viewing to infer other possible Ad's that may
interest a viewer. Some parameters of the learning process
are time watched, volume adjustments, and channel transition
sequences.

A very basic example using SIC information is to infer
that a viewer, who very often skips commercials. but
frequently watches GM car commercials, might like to see a
Ford car commercial, or auto parts. Ad demographic tags
offer similar linkage opportunities, such as if the liked GM
car Ad target middle income male consumers, then an Ad for
computers targeting a similar group would be selected. Some
negative associations are learned by patterns of Ad avoidance
including commercial skipping, and muting or greatly
decreasing the TV volume. This semantic network of user Ad

preferences and behaviors adds value to viewer Ad targeting
by discovering interesting Ad's through past Ad watching
habits, and filtering out Ads that tend to not be interesting
to the viewer. The DME sequences these contextually related
Ad's and learns which type of preferred programming elicits
the most viewing impressions. The viewer may also directly
input Ad preference feedback and the DME will generalize
accordingly.

Over time, the DME creates a rich relational database of
viewer habits and preferences that relates typical Ad's.
programs, and viewing circumstances. A multiplicity of
pattern recognition and machine learning (ML) algorithms
constitute the DME. Methods employed include a novel
variation of the Hidden Markov Model, Fuzzy clustering, and
correlation learning.

Business Model

The DME generates fuzzy rules, probability networks, and
pertinent viewing habits that enhances the AD Mixer's ability
to increase Ad targeting, potentially beyond the Ad customers
own demographic research. This of course directly impacts
MbTV's revenues through better Ad hit rates. Yet, there is
an opportunity to sell this information as another revenue
stream. Companies are often very interested in not only who
buys their products, but also what other products or
entertainment their consumers patronize.

Normally, only large companies can afford to do costly
surveys to learn their customer's typical profile. This
statistical sampling, though, does not usually cover 100% of
their customer base, and covers even less of their potential
consumer base. This is especially true with products that
cut across normal demographic lines, or are otherwise hard to

track. One might expect that a wildly successful consumer research survey would be 50% accurate in profiling a consumer base. Yet, the cost of getting more data often rises exponentially with coverage. Hence, there would still be a substantial population not profiled, that MbTV might be more likely to reach due to its transparent learning in the most ubiquitous social gathering place: the TV. With Data mining and ML techniques, there is an opportunity to discovery statistically significant, complex patterns of associations that arise over the MbTV sample group. For example, if a cruise ship company learns that many people that liked their Ad also like to watch the Business channel in the morning, and listen to Classical Music in the evenings, then they could apply this knowledge as follows:

(1) Strategic advertising campaigns in other media (Classical radio stations),

(2) Design Ad's or outreach to target 'micro-demographic' groups (business people)

(3) For PR: sponsoring, support, or donate to interests of potentially interested consumers (fine Arts)

(4) Redesign Ad's that are not well received (gear towards high stress lifestyle) etc.

AD Manager 'Top Ten pick' biasing module

This module biases the PDM to include programming suggestions into the Top 10 list algorithm that would not have otherwise been normally included. The PDM accepts a biasing signal from the AD Manager that significantly increases the likelihood that a competing, possibly less preferred, program is displayed in the Top 10 list. A fee is

charged for this preferential Top 10 list, content advertising service. In this context, the word 'Ad' is loosely used to mean that the Top 10 content suggestion list is, in whole or in part, used to advertise possibly interesting programming from a content provider.

When the AD Manager provides no bias, the PDM ranks programming options according to past learned viewing history. The Top 10 ranked programs are selected to make the Top 10 list. An exception to the method occurs when a certain number of the top-10 ranked programs, are in the same category. One way to encourage diversity, is to ignore the excess similar entries, and choose lower ranked, but more diverge programs. A given category's representation is highly biased towards only the most preferred predictions. These predictions are based on past viewing behavior. Similar, but competing, programming will be ranked very low if the viewer has not previously visited the channel often. In this case, and more generally, MbTV receives a fee from a content provider to bias, or ensure, that their viewer relevant content is displayed in the Top 10 list, even if it is not ranked high enough for inclusion. Higher fees could be charged to receive better Top 10 list placement, or to supersede competing Ad's. This premium could be modeled similar to the grocery store product shelf placement fees paid by vendors.

For example, if a viewer always watches business news on CNN, then the Top 10 list would almost certainly suggest only upcoming business news programs on CNN. If a Top 10 Ad, from say FOX news, is registered on the AD manager, then an appropriate bias signal is sent to the PDM to insert the FOX news listing in the Top 10 list. In this way, there is a passive opportunity for content companies to target

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advertisements to viewers watching competitors content. This
is not currently possible currently, as competitors block
Ad's from one another's networks. One would never see an Ad
for CNBC's 'Market Wrap' on CNN's 'Money Line', but the AD
Manager could passively suggest the CNBC program to the
targeted viewer.

Product Advertising

Ad's about products are very similar to Ad's about
programming content, except that we have no practical way to
determine if an Ad resulted in a purchase, or increased the
likelihood of a future purchase. This would require T-
commerce. A precursor to a full T-commerce solution to
'close the loop' on product Ads, could be to have a product
information request/delivery mechanism as a way to increase
the certainty that a viewer is interested, and, thus, more
likely to purchase the product.

SIC codes are an important method to relate viewer's Ad
preferences to actual product categories. MbTV learns the
viewer's product category preferences, very similar to genre
programming preferences, and increases targeting
effectiveness by matching viewers with product Ads they have
already demonstrated a preference for. Many companies,
especially large ones, will have extensive, and very costly
to acquire, demographic information attached to the Ad's
metadata. In the standard model, the teamed preferences for
various SIC categories provides a certain measure of
targeting, and a revenue stream. The addition of demographic
information, potentially, increases targeting, resulting in
more revenues. Another novel way that MbTV generates
additional revenues, is by learning statistically significant
relationships between advertiser provided Ad SIC codes and

demographic information, and a viewer preferences. In this way, a Ad customer who has poor, or possibly no demographic target research, can leverage MbTV's learned demographic relationships to similar product SIC codes from other advertisers. Over time, MbTV grows a proprietary information base relating products to SIC code, which potentially goes well beyond the original demographic research provided to the system. In one aspect, this enables MbTV to charge a premium to tier II or tier III Ad customers, who can not afford demographic research, but would greatly benefit consumer targeting if they had it. In this model, everyone is benefited. Importantly, the choice of SIC codes as a product/service Ad categorizing scheme is ideal, since every company already have SIC codes that define what product/services they offer. Thus, there is no additional infrastructure, or effort required. Moreover, MbTV applies all the same algorithms and results achieved through the use of EPG genre codes for programming, to product/service based SIC code Ad targeting.

Content Advertising

In an active version of content advertising, a non-competitive content provider submits their Ad video to the Ad server, for showing on another network. Current practice is for a network to buy an Ad on another network, and hope that the viewers of the Ad will later watch the content advertised. The only way for the Ad customer to validate the effectiveness of the Ad is to use Neilsen, or a similar TV viewing surveyors, to estimate how many people watched the At and later watched the advertised program. This is feedback is very costly, time consuming, and inefficient to gather. Under the MbTV model, the PDM determines the appropriate

viewers and programs to show the content Ad to, then the Ad mixer displays the Ad, and monitors the viewer to confirm if he/she actually watched the content advertised, and receive a fee for the Ad impression. The fee can be determined by statistical sampling, or by direct feedback to the MbTV Ad server of each Ad impression and additional each confirmed viewing of the content advertised. This model increases the targeting capabilities of the Advertisements, while greatly reducing the total cost to the Advertiser, since they only pay for actual results, and required no expensive marketing research or demographics to mount an effective advertising campaign. Importantly, content Ads are basically T-commerce (interactive television based product purchasing), where the product is another program to watch, and the purchase is the actual viewing of the program. The advantage MbTV has over tradition methods of advertising programming on another TV channel, is at least two fold: 1. MbTV can target the Ad potentially more accurately by using the learned viewer preferences, and 2. MbTV can automatically 'close the loop' and determine if the consumer actually 'purchased' the product advertised. MbTV should receive higher Ad premiums since it targets the Ad and the advertising time slot potentially more accurately, and it significantly reduces the cost of assessing the effectiveness of the Ad campaign.

Advanced Knowledge Discovery Enhances Sample Data Collected

General Ad targeting improvements of ADMS compared to the today's TV Ad system are based on the fact that the sample data collected from viewers EUE has more points than available today from equipment used by the industry (e.g., Nielsen).

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Extra behavioral data collected includes example items from the following list and extra detail is given in Appendix B.

Some information is in matrix form, for example, PROGRAM_1, PROGRAM_2 with the Number at each point indicating the probability of transition PROGRAM _1 to PROGRAM_2.

Session Behaviors

- Number of ON/OFF sessions
- Time watched per viewing session

General Channel, Genre, Title, and Word watching behaviors:

Number of different channels and genres viewed-

1. Number of skipped viewing days- viewer's lifestyle, may periodically travel, or switch to other media

2. Frequency visiting per Genre and Channel- viewer's interest

3. Time watched per Genre and Channel- viewer's interest

4. Time watched/time available - viewer's interest

5. Statistical distribution of viewer's Channel, Genre, Title, and Words preferences

Some psychometric inferences from Channel, Genre, Title, and Word state transition matrices-

how likely to make certain transitions

how likely is a certain sequence

how likely do certain sequences to happens in only one direction

how likely to start or end in a given state

detects time of day sensitive patterns of behavior

detects behaviors that occur a given time after turn-on, or program start.

time watched per sequence and transition- an indicator of degree of transition preference

state Sequences- tracks state surfing, and long-term sequence blocks such prime-time line-ups

likelihood to skip through particular states

length of skip sequences

ratio of high probability sequence states visited, to all states visited, measures viewer's curiosity

number of sequences per viewing session and time watched per program/session measures viewer's attention span

ratio of high probability states watched, to all states watched, measures viewer's diversity

ratio of high probability states to random probability measures viewer's bias, and repeatability

moods are captured by default as typical transitions sequences that occurs from a given viewer state transition behavior

Coupons

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Use of coupons or identifier code to determine a sale. This measurement of success by measuring a sale is an alternative to determining success of Ad campaign based on demographic target impression success. Coupon may be:

Printed with bar code (if printer available).

Show viewer a number.

Have viewer remember to mention he saw the Ad.

APPENDIX, AdxmI Examples of Web automatic Ad entry

TVAdPlacement

```
<!-- AdWare ELEMENT TVAdPlacement-->

<!ENTITY % demoNumber
"(1|2|3|4|5|6|7|8|9|10|11|12|13|14|15|16|17|18|19|20)">

<!ELEMENT TVAdPlacement (TVBuy+, AdvertiserCode?,
OrderType?)>
<!ELEMENT OrderType (#PCDATA)>

<!ELEMENT TVBuy (ItemID, ReferenceltemID?, Product,
Market?, Channel?, Affiliation?, Network?, StartDate,
EndDate, TimeMatch, Spots, GrossCostPerSpot?,
NetCostPerSpot?, Program?, SpotLength, Audience*, Comment*,
Package?)>

<!ELEMENT AdvertiserCode (#PCDATA)>
<ELEMENT ItemID (#PCDATA)>
<!ELEMENT ReferenceltemID (#PCDATA)>
<!ELEMENT Product (Description, Code*)>

<!-- Multiple Codes of various types (Agency's code,
Advertiser's code, Vendor's code, etc.) can be supplied for
the Buy. The 'type' attribute identifies the type of code.
-->
<!ELEMENT (Code-EMPTY)>
<!ATTLIST Code
    value     CDATA #REQUIRED
    type CDATA #IMPLIED
>

<!ELEMENT Market (Description, Code*)>
<ELEMENT Channel (4PCDATA)>
```

```
<ELEMENT Affiliation (#PCDATA)>
<ELEMENT Network (#PCDATA)>
<ELEMENT NumberOfSpots (#PCDATA)>
<!ELEMENT GrossCostPerSpot (Money)>
<ELEMENT NetCostPerSpot (Money)>
<!ELEMENT Program (Description, Code*)>
<!ELEMENT Duration (#PCDATA)>
<!ATTLIST Duration
     unitOfMeasure  CDATA #IMPLIED
>
<!ELEMENT Package (Description, Code*)>

     TVContractData

     <!-- AdWare ELEMENT TVContractData -->

     <!ELEMENT TVContractData (StartDate, EndDate, DealID,
Office, Audience*, Comment*)>
<!ATTLIST TVContractData
contractType (PROPOSED | REVISION | FINAL)
>

     <!ELEMENT DealID (#PCDATA)>
<!ELEMENT Office (#PCDATA)>
<!ATTLIST Office
     code CDATA #REQUIRED
>

     <!ELEMENT Audience (Demographic, Statistic,
AudienceValue)>
<!ATTLIST Audience
role (Guarantee | %demoNumber) #IMPLIED
>
<!ELEMENT Demographic (Description?, Code*)>
<!ELEMENT Statistic (Description?, Code*)>
<!ELEMENT AudienceValue (#PCDATA)

     <!ELEMENT Comment (CommentLine+)>
<ATTLIST Comment
     id   CDATA #IMPLIED
>
<ELEMENT CommentLine (#PCDATA)>
<ATTLIST CommentLine
     linenumber CDATA #IMPLIED
```

APPENDIX, Behavior Profile Matrices (related to section 5.5)

```
    NUM_VIEWERS; %number of viewers in household, later each
viewer's profile is indexed
LEARN_WINDOW = NUM_WEEKS; %number of weeks to learn over
    %leaming window used to create behavioral model
Tw_LikeCut;     %minutes to determine program interest
Surfing_Cut;     %minutes to determine if surfing between
channels or not
ChanNumList     %table of leagal channel codes
GenreNumList     %table of leagal genre codes
weekEnds (NUM_WEEKS_MAX,1); %array of week ending markers
Viewer_ID(NUM_VIEWERS); %identifies the unique user profile

    WEIGHT_VECTOR(NUM_DIMENSIONS); % is the machine-learned
weightings, or importance, of each measure dimension that
best predicts the user and their preferences.

    Tw_binspace =
[2,5,10,15,30,45,60,90,120,150,180,210,240,600]; %Histogram
bins of time watched, in minutes
%FUZZY membership, time watched categories
QUICKLY_SURFING = 1;
SLOWLY_SURFING = 2;
EXTREMLY_SHORT = 3;
VERY_SHORT = 4;
SHORT = 5;
NOT_SHORT= 6;
TYPICAL = 7;
SLIGHTLY_LONG =8;
FAIRLY_LONG = 9;
LONG = 10;
VERY_LONG = 11;
SUPER_LONG = 12;
EXTREMLY_LONG = 13;
ULTRA_LONG = 14;

    Time_binspace =
[0,200,600,900,1200,1500,1800,2100,2400]; %Histogram bins of
time-of-day, in 24hr time
%FUZZY membership, time watched categories
LATE_NIGHT = 1;
WEE_HOURS = 2;
EARLY_MORNING = 3;
MORNING = 4;
LATE_MORNING = 5;
AFTER_NOON = 6;
LATE_AFTER_NOON = 7;
EVENING = 8;
NIGHT = 9;
```

```
        NUM_CHANNELS = length(ChanNumList);
NUM_GENRES = length(GenreNumList);

        NUM_WKLYCHAN_MAX = NUM_CHANNELS/2; %maximum different
channels logable per week
NUM_WKLYGENRES_MAX = ceil(NUM_GENRES/2); %maximum different
genres logable per week

        Viewer_numSamples(NUM_VIEWERS, 1); %number of sample
points used to build model
ViewrChanWklyHz(NUM_VIEWERS,NUM_WKLYCHAN_MAX); %number of
times each channel is visited per week
ViewrChanWklyTw(NUM_VIEWERS,NUM_WKLYCHAN_MAX); %total time
watched on each channel per week
ViewrGenreWklyHz(NUM_VIEWERS,NUM_WKLYGENRES_MAX); %number of
times each genre is viewed per week
ViewrGenreW'klyTw(NUM_VIEWERS,NUM_WKLYGENRES_MAX); %total
time watched on each genre per week
ViewrChanTw(NUM_VIEWERS,NUM - CHANNELS); %total time watched
on each channel
ViewrGenreTw(NUM_VIEWERS,NUM_GENRES); %total time watched on
each genre

        viewerTwHistAvg(NUM_VIEWERS,NUM_TwHz_BINS); %histogram
distribution of average time watched per program or channel
change

        ViewrTwWklyNUM_VIEWERS,NUM_WEEKS_MAX); %weekly amount of
time watching TV
ViewrTwAvgWkly(NUM_VIEWERS,NUM_WEEKS_MAX); %average weekly
amount of time watching TV
ViewrTwLongWkly(NUM_VIEWERS,NUM_WEEKS_MAX); %longest viewing
session for each week
ViewrTwShortWkly (NUM_VIEWERS,NUM_WEEKS_MAX); %shortest
viewing session for each week

        ViewrSessions_wkly(NUM_VIEWERS,NUM_WEEKS_MAX); %number
of viewing session for each week
ViewrNumChngs_%wkly(NUM_VIEWERS.NUM_WEEKS_MAX), %number of
content changes for each week
ViewrTw_Tavail_wkly(NUM_VIEWERS,NUM_WEEKS_MAX); % time
watched/program_time_available over Tw_like_cut for each week
ViewrNumChanWkly(NUM_VIEWERS,NUM_WEEKS_MAX); %number of
different channels watched for each week
ViewrNumGenreWkly(NUM_VIEWERS,NUM_WEEKS_MAX); %number of
different genres watched for each week

        ViewrNum0Weeks(NUM_VIEWERS,1); %number of week or days
with no TV viewing
```

```
ViewrAvgWklyTw(NUM_VIEWERS,1), %weekly average of above
define data
ViewrAvgWkly Sessions(NUM_VIEWERS,1), %weekly average of
above define data
ViewrAvgWklyNumChngs(NUM_VIEWERS,1); %weekly average of above
define data
ViewrAvgWklyTw_Tavail(NUM_VIEWERS,1); %weekly average of
above define data
ViewrAvgWklyNumChan(NUM_VIEWERS,1); %weekly average of above
define data
ViewrAvgWklyNumGenre(NUM_VIEWERS,1), %weekly average of above
define data

     ViewrMinWklyTw(NUM_VIEWERS,1); %weekly minimum of above
define data
ViewrMinWklySessions(NUM_VIEWERS,1); %weekly minimum of above
define data
ViewrMinWklyNumChngs(NUM_VIEWERS,1); %weekly minimum of above
define data
ViewrMinWklyTw_Tavail(NUM_VIEWERS,1); %weekly minimum of
above define data
ViewrMinWklyNumChan(NUM_VIEWERS,1); %weekly minimum of above
define data
ViewrMinWklyNumGenre(NUM_VIEWERS,1); %weekly minimum of above
define data

     ViewrMaxWklyTw(NUM_VIEWERS,1); %weekly maximum of above
define data
ViewrMaxWklySessions(NUM_VIEWERS,1); %weekly maximum of above
define data
ViewrMaxWklyNumChngs(NUM_VIEWERS,1); %weekly maximum of above
define data
ViewrMaxWklyTw_Tavail(NUM_VIEWERS,1); %weekly maximum of
above define data
ViewrMaxWklyNumChan(NUM_VIEWERS,1); %weekly maximum of above
define data
ViewrMaxWklyNumGenre(NUM_VIEWERS,1); %weekly maximum of above
define data

     ViewrSdvWklyTw(NUM_VIEWERS,1); %weekly standard
deviation of above define data
ViewrSdvWklySessions(NUM_VIEWERS,1); %weekly standard
deviation of above define data
ViewrSdvWklyNumChngs(NUM_VIEWERS,1); %weekly standard
deviation of above define data
ViewrSdvWklyTw_Tavail(NUM_VIEWERS,1); %weekly standard
deviation of above define data
ViewrSdvWklyNumChan(NUM_VIEWERS,1); %weekly standard
deviation of above define data
```

```
Vie wrSdvWklyNumGerire(NUM_VIEWERS,1); %weekly standard
deviation of above define data

    chan_hist_wkly(NUM_WEEKS,NUM_WKLYCHAN_MAX); %frequency
visiting only for channels viewed
chan_idx_wkly(NUM_WEEKS,NUM_WKLYCHAN_MAX); %index table of
channels viewed

    genre_hist_wkly(NUM_WEEKS,NUM_WKLYCHAN_MAX); %frequency
visiting only for genres viewed
genre_idx_wkly(NUM_WEEKS,NUM_WKLYCHAN_MAX); %index table of
genres viewed

    Tw_pChangeHist_wkly(NUM_WEEKS,NUM_TwHz_BINS); %weekly
time watched per content or channel change
Tw_p_sesionHist_wkly(NUM_WEEKS,NUM_TwHz_BINS); %weekly time
watched per viewing session

    usrChanList;   %ascending sort of watched channels in
Learning period
NUM_USR_CHAN = length(usrChanList);
usrGenreList;  %ascending sort of watched genres in Learning
period
NUM_USR_GENRE = length(usrGenreList);

    %ChannTransMtx, and its family, are track transitions
that are greater than 'Surfing_Cut'
ChannTransMtx(NUM_USR_CHAN+1,NUM_USR_CHAN+1); %channel
transition matrix, where rows are the 'from' channel. and
columns are the 'to' channel, each transition increments its
counter
ChanTwTransMtx(NUM_USR_CHAN+1,NUM_USR_CHAN+1,NUM_TwHz_ BINS);
%time watched per channel transition, where rows are the
'from' channel, and columns are the 'to' channel, each
transition has a histogram distribution of how much time
watched for since the last transition
ChanSequTwHistMtx(NUM_USR_CHAN+1,NUM_USR_CHAN+1,NUM_TwHz_BINS
); %for each channel transition, histogram of amount of time
watched since TV turn-on
ChanTransTHistMtx
(NUM_USR_CHAN+1,NUM_USR_CHAN+1,NUM_TIME_BINS); %for each
channel transition, histogram of time of day the transition
occurred

    GenreTransMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1); %same
definition as channel, but for genre
GenreTwTransMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1,NUM_TwHz_BINS
); %same definition as channel, but for genre
GenreSequTwHistMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1,NUM_
```

TwHz_BINS); %same definition as channel, but for genre
GenreTransTHistMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1,NUM_
TIME_BINS); %same definition as channel, but for genre
GenreTransMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1); %same
definition as channel, but for genre
TitIeTransMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1); %same
definition as channel, but for program title
TitleTwTransMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1,NUM_TwHZ-
BINS), %same definition as channel, but for program title
TitleSequTwHistMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1,NUM_
TwHz_BINS); %same definition as channel, but for program
title
TitleTransTHistMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1,NUM_TIME_B
INS); %same definition as channel, but for program title
TitleTransMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1); %same
definition as channel, but for program title

WordTransMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1); %same
definition as channel, but for words in title or descriptions
WordTwTransMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1,NUM_TwHz_BINS)
; %same definition as channel, but for words in title or
descriptions
WordSequTwHistMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1,NUM_
TwHz_BINS); %same definition as channel, but for words in
title or descriptions
WordTransTHistMtx (NUM_USR_GENRE+1,NUM_USR_GENRE+1,NUM_
TIME_BINS); %same definition as channel, but for words in
title or descriptions
WordTransMtx(NUM_USR_GENRE+1,NUM_USR_GENRE+1); %same
definition as channel, but for words in title or descriptions

%SurfChanTransMtx, and its family, are track transitions
that are less than 'Surfing_Cut'
SurfChanTransMtx(NUM_USR_CHAN+1,NUM_USR_CHAN+1); %channel
transition matrix, where rows are the 'from' channel, and
columns are the 'to' channel, each transition increments its
counter
SurfChanTwTransMtx(NUM_USR_CHAN+1,NUM_USR_CHAN+1,NUM_TwHz_BIN
S); %time watched per channel transition, where rows are the
'from' channel, and columns are the 'to' channel, each
transition has a histogram distribution of how much time
watched for since the last transition
SurfChanSequTwHistMtx(NUM_USR_CHAN+1,NUM_USR_CHAN+1,NUM_
TwHz_BINS); %for each channel transition, histogram of amount
of time watched since TV turn-on
SurfChanTransTHistMtx(NUM_USR_CHAN+1,NUM_USR_CHAN+1,NUM_
TIME_BINS); %for each channel transition, histogram of time
of day the transition occurred

KnownChanSequences(MAX_NUM_SEQUENCES,NUM_USR_CHAN+1);
%tracks the higher probability non-surfing channel transition
sequences
SequenceChanCnt(MAX_NUM_SEQUENCES,NUM_USR_CHAN+1); %counts
the total number of non-surfing channels for each
KnownChanSequences, including low probability ones it does
not included

KnownGenreSequences(MAX_NUM_SEQUENCES,NUM_USR_CHAN+1);
%tracks the higher probability non-surfing genre transition
sequences
SequenceGenreCnt(MAX_NUM_SEQUENCES,NUM_USR_CHAN+1); %counts
the total number of non-surfing genres for each
KnownGenreSequences, including low probability ones it does
not included

KnownTitleSequences(MAX_NUM_SEQUENCES,NUM_USR_CHAN+1);
%tracks the higher probability non-surfing title transition
sequences
SequenceTitleCnt(MAX_NUM_SEQUENCES,NUM_USR_CHAN+1); %counts
the total number of non-surfing titles for each
KnownTitleSequences, including low probability ones it does
not included

KnownSurfChanSequences(MAX_NUM_SEQUENCES,NUM_USR_CHAN+1)
; %tracks the higher probability surfing channel transition
sequences
SurfSequenceChanCnt(MAX_NUM_SEQUENCES,NUM_USR_CHAN+1);
%counts the total number of surfing channels for each
KnownSurfChanSequences, including low probability ones it
does not included

KnownSurfGenreSequences(MAX_NUM_SEQUENCES,NUM_USR_CHAN+1
); %tracks the higher probability surfing genre transition
sequences
SurfSequenceGenreCnt(MAX_NUM_SEQUENCES,NUM_USR_CHAN+1);
%counts the total number of surfing genres for each
KnownSurfGenreSequences, including low probability ones it
does not included

KnownSurfTitleSequences(MAX_NUM_SEQUENCES,NUM_USR_CHAN+1);

%tracks the higher probability surfing title transition

sequences

SurfSequenceTitleCnt(MAX_NUM_SEQUENCES,NUM_USR_CHAN+1);

%counts the total number of surfing titles for each

KnownSurfTitIeSequences, including low probability ones it does not include.

Porting Processes

Certain aspects of the MbTV software embodying the preferred embodiment of the present invention depend on the customer's platform and architecture. To optimize the customer's use of the software on a specific platform, certain parameters are provided for the customer to tune the software. These parameters specified in the *custom.h* file, and are described in the table below. The customer must modify these custom parameters before integrating MbTV software into customer modules.

MACRO NAME	MACRO DESCRIPTION
MBTV_SDM_PROCESS_PRIORITY	This specifies the PRIORITY at which the SDM Background Task executes. Generates Recording Events for Automatic and Explicit Record Requests. This value is defined by the customer based on the Operating System and the system architecture.
MBTV_PDM_PROCESS_PRIORITY	This specifies the PRIORITY at which the PDM Background Task executes. Does housekeeping tasks for the PDM Module. This value is defined by the customer based on the Operating System & the system architecture
MBTV_DATA_FILE_NAME_1	This specifies the Full

	Pathname for MbTV Data File. This value is defined by the customer based on the system architecture of the target platform. MbTV will use this file to store MbTV specific data. The customer can use these values to control where MbTV files are stored.
MBTV_DATA_FILE_NAME_2	This specifies the Full Pathname for MbTV Data File. This value is defined by the customer based on the system architecture of the target platform. MbTV will use this file to store MbTV specific data. The customer can use these values to control where MbTV files are stored.
MBTV_DATA_FILE_NAME_3	This specifies the Full Pathname for MbTV Data File. This value is defined by the customer based on the system architecture of the target platform. MbTV will use this file to store MbTV specific data. The customer can use these values to control where MbTV files are stored.
MBTV_DATA_FILE_NAME_4	This specifies the Full Pathname for MbTV Data File. This value is defined by the

	customer based on the system architecture of the target platform. MbTV will use this file to store MbTV specific data. The customer can use these values to control where MbTV files are stored.
MBTV_DATA_FILE_NAME_5	This specifies the Full Pathname for MbTV Data File is value is defined by the customer based on the system architecture of the target platform. MbTV will use this file to store MbTV specific data. The customer can use these values to control where MbTV files are stored.
MBTV_DATA_FILE_NAME_6	This specifies the Full Pathname for MbTV Data File. This value is defined by the customer based on the system architecture of the target platform. MbTV will use this file to store MbTV specific data. The customer can use these values to control where MbTV files are stored.
MBTV_DATA_FILE_NAME_7	This specifies the Full Pathname for MbTV Data File. This value is defined by the customer based on the system architecture of the target

	platform. MbTV will use this file to store MbTV specific data. The customer can use these values to control where MbTV files are stored.
MBTV_DATA_FILE_NAME_8	This specifies the Full Pathname for MbTV Data File. This value is defined by the customer based on the system architecture of the target platform. MbTV will use this file to store MbTV specific data. The customer can use these values to control where MbTV files are stored.
MBTV_DATA_FILE_NAME_9	This specifies the Full Pathname for MbTV Data File. This value is defined by the customer based on the system architecture of the target platform. MbTV will use this file to store MbTV specific data. The customer can use these values to control where MbTV files are stored.
MBTV_DATA_FILE_NAME_10	This specifies the Full Pathname for MbTV Data File. This value is defined by the customer based on the system architecture of the target platform. MbTV will use this file to store MbTV specific

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	data. The customer can use these values to control where MbTV files are stored.
MBTV_MAX_NUM_PROFILE	Maximum number of Profiles supported by MbTV up to a maximum of 6. This value is used by the pgmRating field in the pgmInfo_t structure.
MBTV_DEFAULT_NUM_PROFILES	Default number of profiles created by MbTV.
MBTV_MAX_PROFILE_NLEN	Maximum length for MbTV Profile Names.
MBTV_MAX_NUM_CHANNELS	Maximum number of channels created by MbTV
MBTV_MAX_NUM_SFILTERS	Maximum number of filters that can be created.
MBTV_MAX_TITLE_LEN	Maximum length for Program Title Names. This is dependent on the EPG Data feed and the External EPG Implementation. This value is used for the pgmTitle field in recRequest and pgmInfo_t structures.
MBTV_MAX_SFILTER_PLEN	Maximum length for Filter String Parameter used by MbTV. This value is used by filterString field in the filter_t structure.
MBTV_MAX_NUM_TDBITRATE	Maximum number of type defined bit rates
MBTV_MAX_NUM_SFILTER_PARAMS	Maximum number of

	Parameters allowed for Filter String. This value is used by filterString field in the filter_t structure.
MBTV_MAX_FTYPE_NLEN	Maximum length for Filter Type Names. This value is used by filterTypeName field in the filterType_t structure.
MBTV_MAX_TDEF_PLEN	Maximum length for strings associated with Type Default Bit Rate structure. This value is used by tdValue field in tdBitRate_t structure
MBTV_MAX_NUM_TDEF_PARAMS	Maximum number of Parameters allowed for Type Default Bit Rate structure. This value is used by tdValue field in tdBitRate_t structure
MBTV_MAX_MESG_SIZE	Maximum size of Messages in Message Queue needed by MbTV. This value will be used by MbTV modules and OS I/F Module.
MBTV_MAX_CHNL_DATA_SIZE	Maximum size of the Channel Data provided by the External EPG Module. This would depend on the EPG Data feed and implementation used. This value will be used by SDM and External EPG Module. This value will be decided by the External EPG Module.

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MBTV_CHLINEUP_NOTIFY	
MBTV_MAX_CHNL_PARAM_SIZE	Maximum size of the individual Channel Parameter provided by the External EPG Module. This depends on the EPG Data feed & implementation. This value will be used by SDM and External EPG Module. This value will be decided by the External EPG Module.
MBTV_MAX_PGM_DATA_SIZE	Maximum size of the Program Data provided by the External EPG implementation. This would depend on the EPG Data feed & implementation. This value will be used by SDM and External EPG Module. This value will be decided by the External EPG Module.
MBTV_MAX_PGM_PARAM_SIZE	Maximum size of the individual Program Parameter provided by the External EPG Module. This depends on the EPG Data feed & implementation. This value will be used by SDM and External EPG Module. This value will be decided by the External EPG Module.
MBTV_EPG_TITLE_PNUM	Parameter Number for Program Title Info. This

	information is dependent on the EPG Data feed and implementation. MbTV will use this value to request program Title from the EPG module.
MBTV_MAX_NUM_EPG_PGM_PARAM	Maximum number of Program Parameters provided by the External EPG module. This depends on EPG data feed and implementation.
MBTV_MAX_NUM_EPG_CHNL_PARAM	Maximum number of Channel Parameters provided by the External EPG module. This would depend on the EPG data feed and implementation.

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Viewer Interaction

The following section exemplifies the manner in which a viewer may interact with software and hardware embodying the present invention.

➢ *Main Grid Screen*
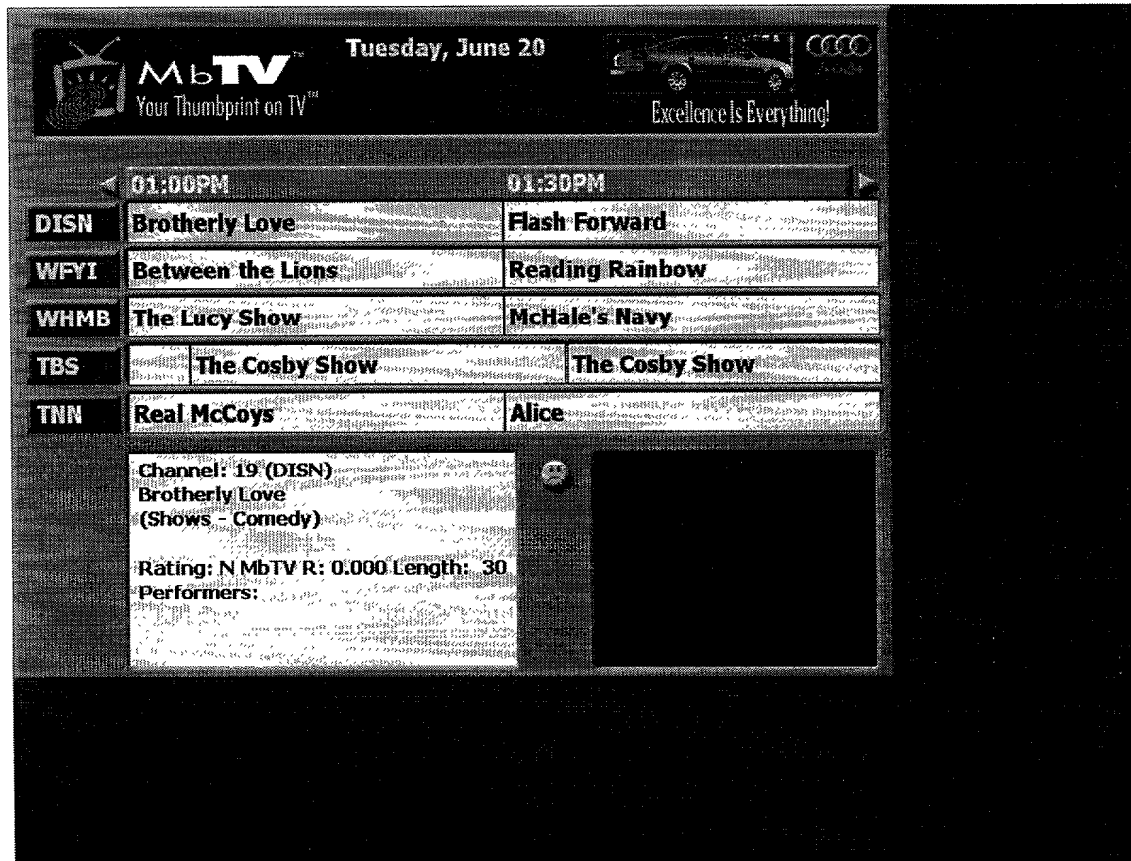
Screen Details
1. An item is always selected in the grid. Preview Screen is shown for the selected program.
2. The times and/or channel names are changed to reflect the grid selection. Date should also be changed when the selection is moved to another date.
3. When navigating within the grid, channel displayed in the preview window is changed only when the user presses enter/select. The details of the program and the Rating Image of the program are changed to reflect the selection. If the program which occurs in the future is selected and user presses enter, do not change the channel. (Alternative is to present a black preview window.)
4. Program Names are to be separated using a thick line as above.

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5. Handle partial programs correctly. Display partial title. But when the program is selected, show the description, rating and preview window.

Keys Allowed

1. Navigation within the grid can be done using left, up, down and right arrow keys.
2. Hot Keys to Switch to Full Screen, MbTV Picks, Storage List are permitted.
3. Login/Logout Menu, Theme Menu, Main Configuration Menu Hot keys should present appropriate menus.
4. Enter selects the program to be displayed in the preview window.
5. Selection Menu, When Live Program is selected, the record menu is to be shown, and when virtual channel is selected, lock menu is shown. (Lock menu is superset of record menu with one additional item for Locking the current program)
6. To release a lock, the current profile must have appropriate privileges,

➢ *MbTV Picks   (Also called Favorites and Top 10 List)*

Screen Details

1. When Picks key is pressed the above screen is presented to the user. The order of items in the list should be reverse of the
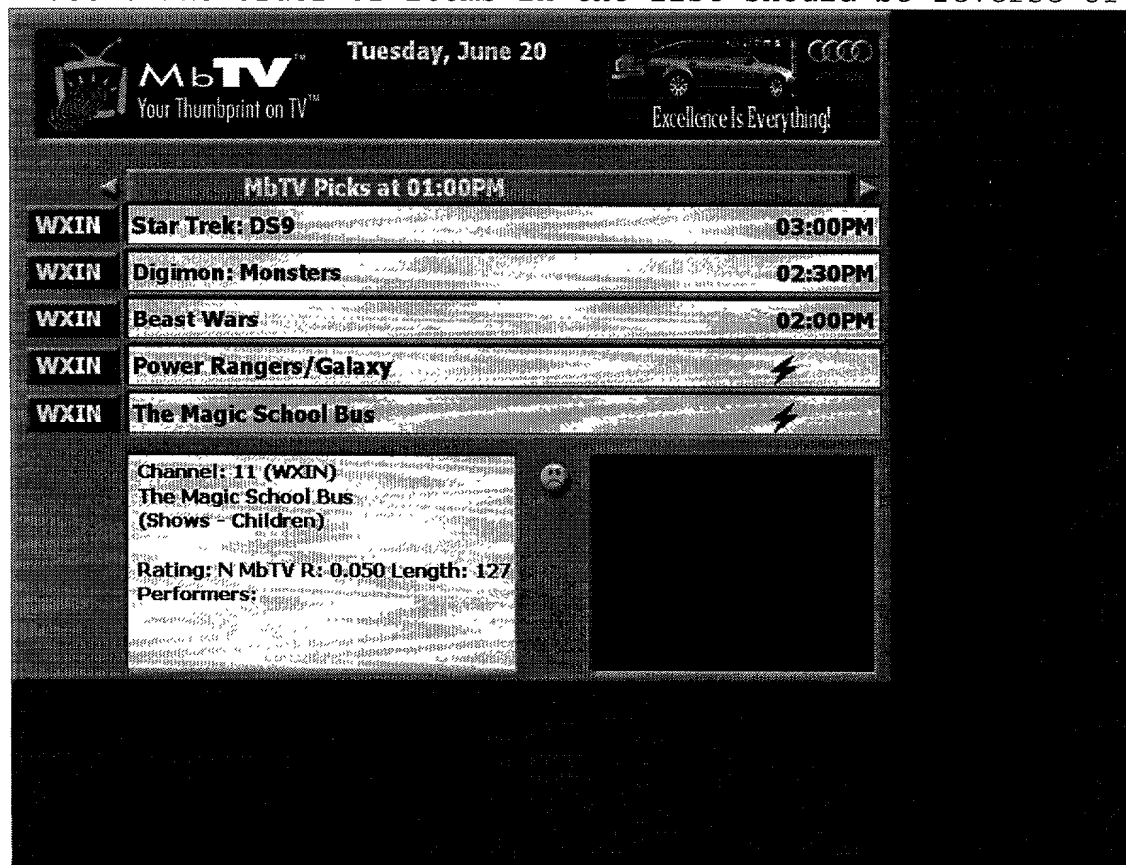
above (i.e. live programs listed first then order programs by time.)
2. The default selection is the top item in the list.
3. If a future (not live) program is selected, then for the purpose of the preview window, do not change channel and leave it at the previous selection. (Alternative is to present a black preview window.)
4. Rating Image of the program and description of the program are changed when selection changes.
5. To exit out of this screen, Picks key needs to be pressed.

Keys Allowed
1. Navigation within the grid can be done using left, up, down and right arrow keys.
2. Hot Key to Switch to Grid is permitted.
3. Login/Logout Menu, Theme Menu, Main Configuration Menu Hot keys should present appropriate menus.
4. Enter selects the program to be displayed in the preview window.
5. On Selection Menu Key, Record menu is presented.
6. When navigating to the right, do not allow the user to move beyond 2 days. (The number of days for which we have EPG data loaded.)

➢ *Expected Recorded Programs (Also called Storage List)*
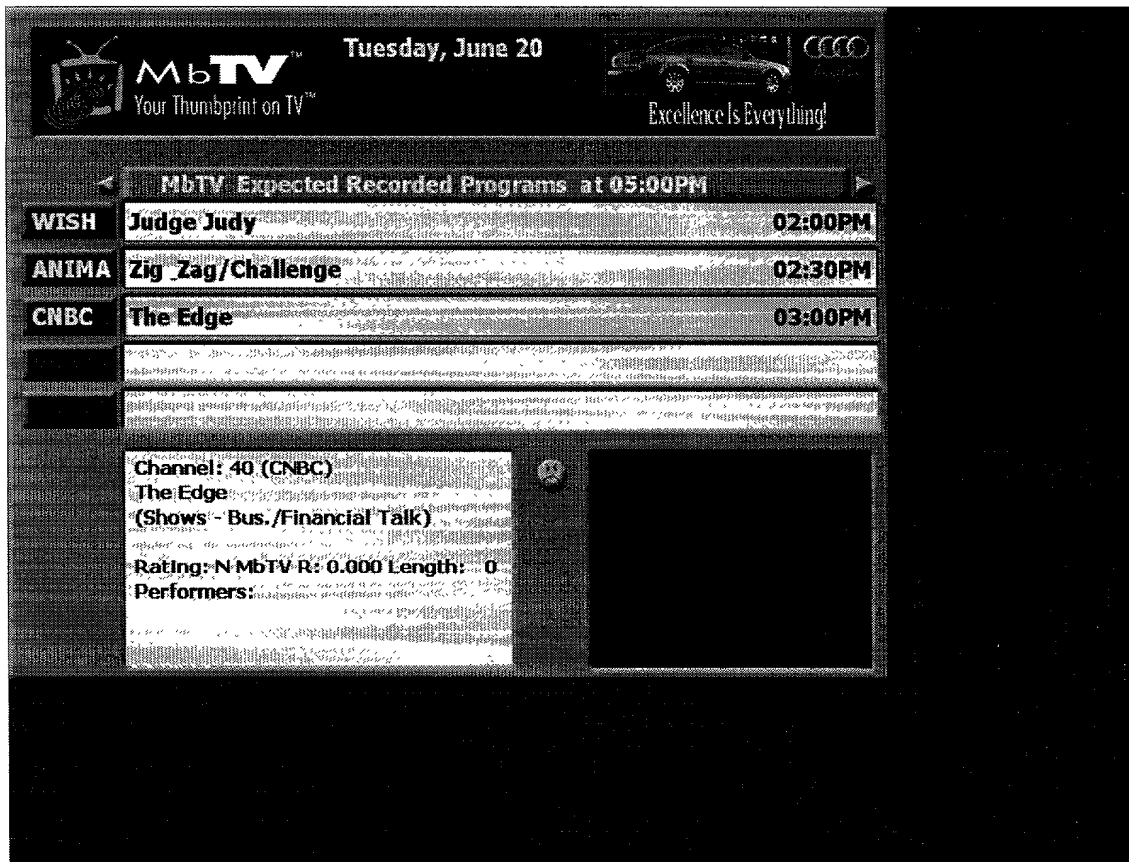
Screen Details

1. If a virtual channel is present and is selected, then display the video corresponding to it.
2. Rating Image of the program and description of the program are changed when selection changes.
3. For the purpose of the preview window, do not change channel and leave it at the previous selection. (Alternative is to present a black preview window.)
4. To exit out of this screen, Picks key needs to be pressed.

Keys Allowed

1. Navigation within the grid can be done using left, up, down and right arrow keys.
2. Hot Key to Switch to Grid is permitted.
3. Login/Logout Menu, Theme Menu, Main Configuration Menu Hot keys should present appropriate menus.
4. Enter Key selects the program to be displayed in the preview window.
5. On Selection Menu Key, Record menu is presented.
6. When navigating to the right, do not allow the user to move beyond 2 days. (The number of days for which we have EPG data loaded.)

Handling Power Off / On

When Power is turned off, save the channel & screen mode which
was selected. Display a black screen with all components hidden.

Screen Mode	Action To be performed	Saved Screen Mode
Menus	Clear all menus	Grid
Storage List		Gird
Favorites		Grid
Full Screen		Full Screen
Grid		Grid

When power is turned on, select saved channel in one of grid or
Full screen mode.
When displaying Grid display programs at current time.

.Menu Development
  • Menu Descriptor File Format
    Questions:
    Primarily there are three kinds of menu Items
    1. Menu Items without any values.
       These lead to Sub Menus.
    2. Menu Items with normal text values.
       Once an item is selected, an action is taken based
       on the selection.
    3. Menu Items with editable text values.
       These are used for editing passwords, specifying
       profile names etc.
    4. Menu Items with Sliders.
       These items provide visual representation of an item
       value.
    5. Menu Items with Bitmap Images.
       These items provide visual representation of an item
       value.

    Two bitmaps are used for presentation of a menu.
    1. Top Header section image. Stretched to fit an area
       as required.
    2. Menu Bottom Bitmap also stretched fit an area as
       required.

  • Menu Object Manager Development
       Role: Read the Menu Descriptor file for a given menu
and paint the screen.
       Also take necessary actions based on the user
selection.

- Individual Menus Implementation
     Task: Provide the Menu descriptor file for this menu.

➤ **Existing Menus**

SelectionMenuObject

Record Menu or Lock Menu based on selected channel type

Record Menu

Internal Name: Record Menu

Suggested Title: MbTV Channel Menu

Menu Item	Item Values	Type of Item	Action On Enter
Record	"None", "Once", "Daily", "Weekly", "When Available"	Scrolling List of Constant Values.	Save all menu item modifications. If a new recording command is issued, If **SDMGetNumRecConflicts** call returns a false, then there are no conflicts If there are conflicts indicated by the above call, Call **SDMGetRecConflicts** for each conflict and format for presentation to the User. These conflicting requests are kept in temporary memory until the record request is fully handled. If the user chooses

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| | | | to override **all** conflicts, then **SDMSetRecRequest** is called for each conflict with the override flag, until all conflicts are resolved. |
| MbTV Rating | "0", "10", "20", "30", "40", "50", "60", "70", "80", "90", represented using 5 rating bitmaps. | Scrolling list of bitmaps | If the rating has been modified save the rating. |

Lock Menu
Internal Name: Lock Menu
Suggested Title: MbTV Channel Menu

Menu Item	Item Values	Type of Item	Action On Enter
Lock	"No", "Yes"	Scrolling List of Constant Values.	Save the property of the program
Record	"None", "Once", "Daily", "Weekly", "When Available"	Scrolling List of Constant Values.	Save all menu item modifications. If a new recording command is issued, If **SDMGetNumRecConflicts** call returns a false, then there are no conflicts

If there are conflicts indicated by the above call, Call **SDMGetRecConflicts** for each conflict and format for presentation to the User. These conflicting requests are kept in temporary memory |

			until the record request is fully handled.
			If the user chooses to override all conflicts, then **SDMSetRecRequest** is called for each conflict with the override flag, until all conflicts are resolved.
MbTV Rating	"0", "10", "20", "30", "40", "50", "60", "70", "80", "90", represented using 5 rating bitmaps.	Scrolling list of bitmaps	If the rating has been modified save the rating.

ClearMenuObject   (Virtual Channel Deletion Prompt)

Internal Name: Lock Menu
Suggested Title: MbTV Deletion Alert

Menu Item	Item Values	Type of Item	Action On Enter
Delete	"No", "Yes"	Scrolling List of Constant Values.	If Yes is selected, delete selected virtual channel Program* p = programs[selectedCh annel][selectedProg ram]; Delete((VOID*)p->chID, CHANNEL_TYPE_VIRTUA L, gui->getClockTime());

Internal Name: Theme Menu
Suggested Title: MbTV Theme Menu

Menu Item	Item Values	Type of Item	Action On Enter
"Channel"	None		??? Do we need this item???
Program Type	"Any" Remaining items must be read using the dictionary. char **sStrings; sStrings = Capp_GetDictFilterValues ("ProgramTypes.txt", &nVarCount);	List of Values, Values are loaded at run time.	Fill the srchFilter typedef struct _srchFilter_ { ulong filterTypeID; char searchString[MAX_NUM_PARAMS][MAX_PARAM_LEN]; } srchFilter_t, *psrchFilter_t; filterTypeIDs are to be define Int MbTVGetCriteriaBasedBestPrograms(int, pgmInfo_t *ppgmInfo[], time_t, time_t, int, srchFilter_t *psrchFilter);
Program Category	"Any" Remaining items must be read using the dictionary.	List of Values, Values are loaded at run time.	

	Char **sStrings; sStrings = Capp_GetDictFi lterValues ("ProgramCateg ory.txt", &nVarCount);	
Country	"Any" Remaining items must be read using the dictionary. char **sStrings; sStrings = Capp_GetDictFi lterValues ("Countries.tx t", &nVarCount);	List of Values, Values are loaded at run time.
MPAA Rating	"Any" Remaining items must be read using the dictionary. char **sStrings; sStrings = Capp_GetDictFi lterValues ("MPAARatings. txt", &nVarCount);	List of Values, Values are loaded at run time.

LoginMenuObject   (Login Menu with a list of users)
Internal Name: Login Menu
Suggested Title: MbTV Login Menu
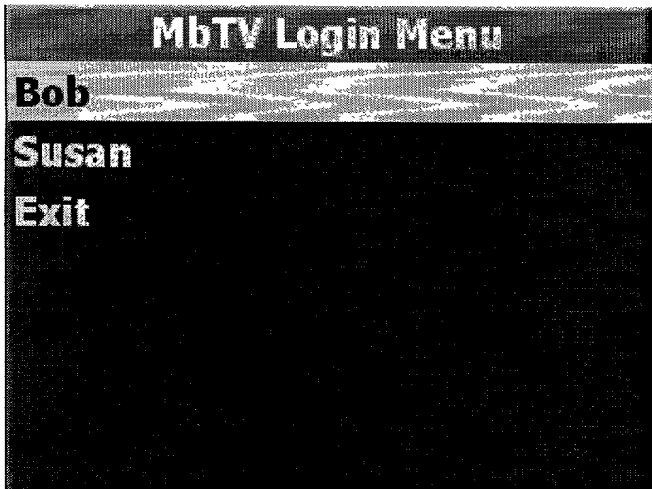
Before presenting this menu, query the list of profiles from PIM using PIM*Profile functions. Please see PIM interface document for details.

After adding these profile names to the menu, add another item called Exit to exit login menu.

Menu Item	Item Values	Type of Item	Action On Enter
Profile Name(s)	None	Conditional (If password Protected) Submenu	Login the selected user
Exit	None	None	Clear Login Menu

LogoutMenuObject

When a user is logged in and login menu key is pressed, the following menu is presented.

Internal Name: Logout Menu
Suggested Title: MbTV Logout Menu
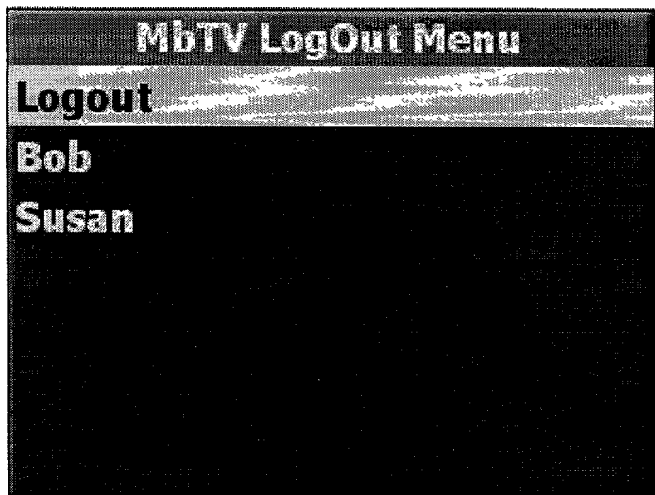
Before presenting this menu, query the list of profiles from PIM
using PIM*Profile functions. Please see PIM interface document
for details.
After adding these profile names to the menu, add another item
called Exit to exit login menu.

Menu Item	Item Values	Type of Item	Action On Enter
Logout	None	Conditional (If password Protected) Submenu	Logout current user.
Profile Name(s)	None	Sub menu	Present profile configuration menu.

LoginPasswordMenuObject   (Login Password if password is
required.)
Internal Name: Login Password Menu
Suggested Title: MbTV Password Menu

If a login or logout is protected by a password, the following
Password Menu is shown. If the password is correct Password
Screen is hidden and User is logged in/out.
If the password is incorrectly entered, the user must press
menuExit(Clear) key to exit out of the menu.

MainConfigMenuObject   (Main Configuration menu)

Internal Name: Main Configuration Menu
Suggested Title: MbTV Configuration Menu
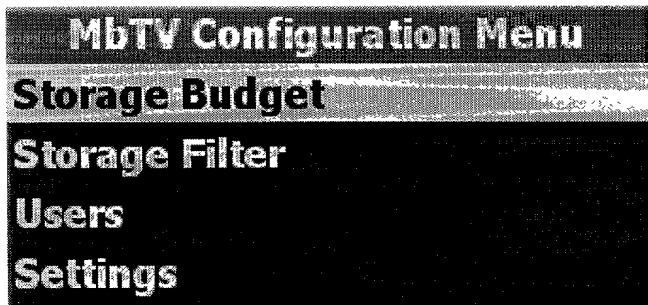
Menu Item	Item Values	Type of Item	Action On Enter
Storage Budget	None	Sub menu	Present Storage Budget menu.
Storage Filter	None	Sub menu	Present Storage Filter menu.
Profiles (Users must be changed to profiles)	None	Sub menu	Present Profiles menu.
Settings	None	Sub menu	Present Settings menu.

StorageBudgetMenuObject   (Storage Budget Menu)

Internal Name: Storage Budget Menu
Suggested Title: MbTV Storage Budget Menu

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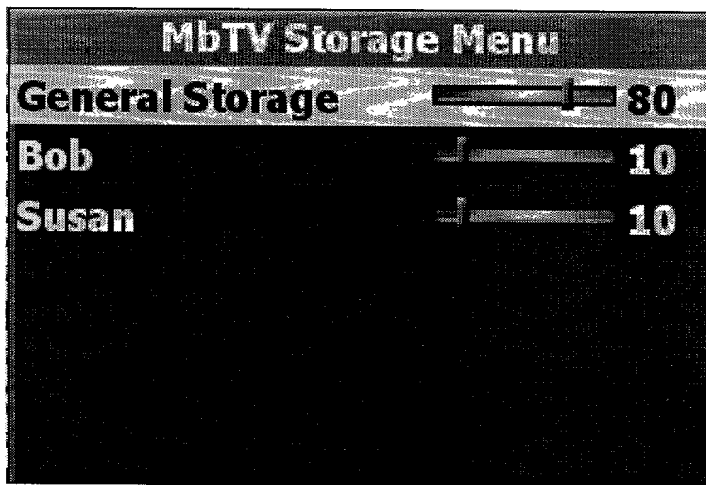
Menu Item	Item Values	Type of Item	Action On Enter
General Storage	0 to 100 represented by a slider	Slider Item	Save all storage budgets
Profile Name	0 to 100 represented by a slider	Slider Item	Save all storage budgets

Storage Budget is represented using _sbudget_ structure.
The functions to get and set storage budget by profile id are
SDMGetSBudget and SDMSetSBudget
General Storage is (100 - (Storage allocated to all profiles))

StorageFilterMenuObject (Storage Filters Menu)
Internal Name: Storage Filter Menu
Suggested Title: MbTV Storage Filter Menu

	Values		Action On Enter
"Channel"	None	Sub Menu	Present Channel

			Storage Filters Sub menus
Program Type	None	Sub Menu	Present Program Type Storage Filter Sub menus
Program Category	None	Sub Menu	Present Program Category Storage Filter Sub menus
Country	None	Sub Menu	Present Country Storage Filter Sub menus
MPAA Rating	None	Sub Menu	Present MPAA Rating Storage Filter Sub menus

SFListMenuObject   (Defined List of Storage Filters)

Channel Filters Menu
Internal Name: Channel Storage Filters Menu
Suggested Title: MbTV Channel Storage Filters Menu

Menu Item	Item Values	Type of Item	Action On Enter
Channel Names	None	Sub Menu	Present Filter Values Filters Sub menus
Add New Filter	None	Sub Menu	Present Add New Filter Sub Menu

Program Type Filters Menu
Internal Name: Program Type Storage Filters Menu
Suggested Title: MbTV Program Type Storage Filters Menu
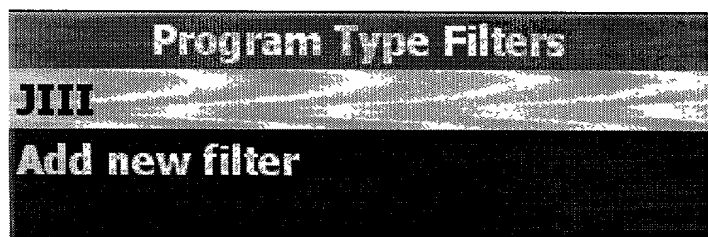
Menu Item	Item Values	Type of Item	Action On Enter
Program Type Names	None	Sub Menu	Present Filter Values Filters Sub menus
Add New Filter	None	Sub Menu	Present Add New Filter Sub Menu

Program Category Filters Menu

Internal Name: Program Category Storage Filters Menu
Suggested Title: MbTV Program Category Storage Filters Menu
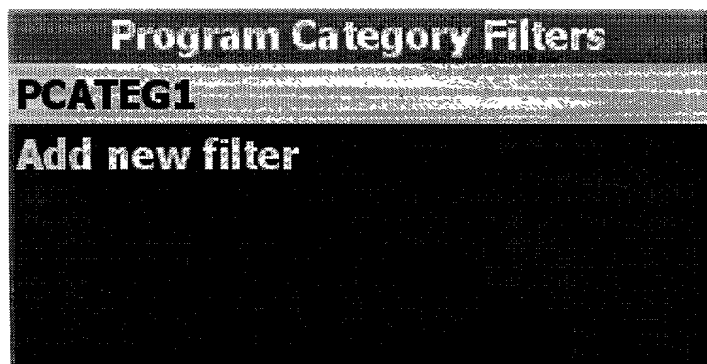
Menu Item	Item Values	Type of Item	Action On Enter
Program Category Names	None	Sub Menu	Present Filter Values Filters Sub menus
Add New Filter	None	Sub Menu	Present Add New Filter Sub Menu

Country Filters Menu

Internal Name: Country Storage Filters Menu
Suggested Title: MbTV Country Storage Filters Menu
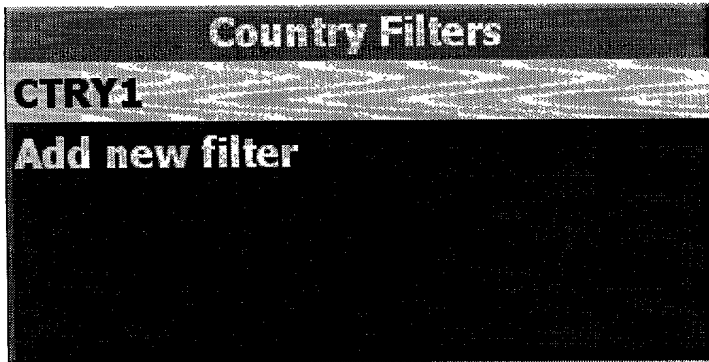
Menu Item	Item Values	Type of Item	Action On Enter
Country Names	None	Sub Menu	Present Filter Values Filters Sub menus
Add New Filter	None	Sub Menu	Present Add New Filter Sub Menu

Internal Name: MPAA Rating Storage Filters Menu
Suggested Title: MbTV MPAA Rating Storage Filters Menu
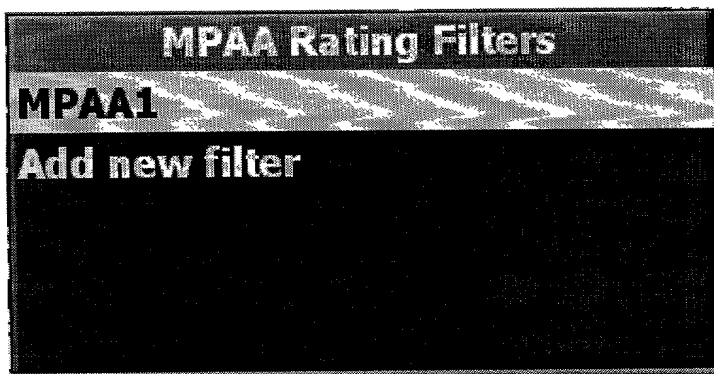
Menu Item	Item Values	Type of Item	Action On Enter
MPAA Ratings	None	Sub Menu	Present Filter Values Filters Sub menus
Add New Filter	None	Sub Menu	Present Add New Filter Sub Menu

SFShowMenuObject   (Properties of a storage filter)
Representative Picture shown, each one of the filter types has a similar Menu.
Internal Name: Channel Storage Filter Properties
Suggested Title: MbTV Channel Storage Filter Properties

Internal Name: Program Type Storage Filter Properties
Suggested Title: MbTV Program Type Storage Filter Properties

Internal Name: Program Categories Storage Filter Properties
Suggested Title: MbTV Program Categories Storage Filter Properties

Internal Name: Country Storage Filter Properties
Suggested Title: MbTV Country Storage Filter Properties

Internal Name: MPAA Rating Storage Filter Properties
Suggested Title: MbTV MPAA Rating Storage Filter Properties
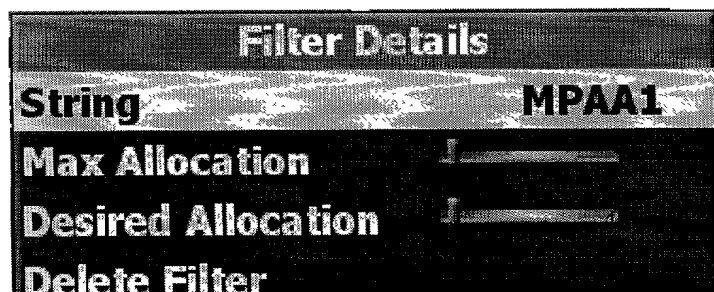
Properties of a filter are shown to the user and they are configurable from this menu.

Menu Item	Item Values	Type of Item	Action On Enter
String	Static Name	Static Filter Name	If any of the properties is changed, save the properties.
Max Allocation	0 to 100 represented by a slider	Slider	If any of the properties is changed, save the properties.
Desired Allocation	0 to 100 represented by a slider	Slider	If any of the properties is changed, save the properties.
Delete Filter	None	None	Delete this filter.

SFAddMenuObject   (Addition of Storage Filter)

Representative Picture shown, each one of the filter types has a similar Menu.

Internal Name: Add Channel Storage Filter
Suggested Title: MbTV Add Channel Storage Filter

Internal Name: Add Program Type Storage Filter
Suggested Title: MbTV Add Program Type Storage Filter

Internal Name: Add Program Categories Storage Filter
Suggested Title: MbTV Add Program Categories Storage Filter

Internal Name: Add Country Storage Filter
Suggested Title: MbTV Add Country Storage Filter

Internal Name: Add MPAA Rating Storage Filter
Suggested Title: MbTV Add MPAA Rating Storage Filter
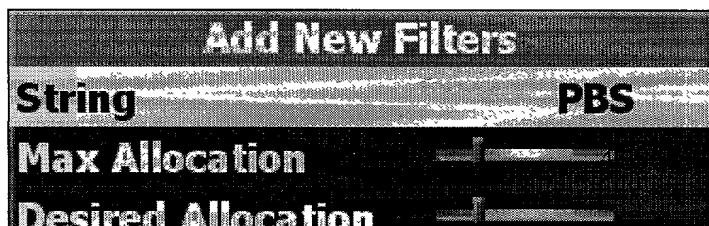
The values of the String are based on dictionary for each item.
Char   **sStrings;
sStrings = Capp_GetDictFilterValues ("ProgramCategories.txt",
&nVarCount);
sStrings = Capp_GetDictFilterValues ("ProgramTypes.txt",
&nVarCount);
sStrings = Capp_GetDictFilterValues ("MPAARating.txt",
&nVarCount);
sStrings = Capp_GetDictFilterValues ("Countries.txt",
&nVarCount);

The Channel names are read from the dictionary of channel name
using the following functions. EPGGetNumChannels, EPGGetChannelID
and EPGGetChannelParams.

Menu Item	Item Values	Type of Item	Action On Enter
String	Based on the type	List the values are read from dictionary file.	Add a new filter and save the properties.
Max Allocation	0 to 100 represented by a slider	Slider	Add a new filter and save the properties.
Desired Allocation	0 to 100 represented by a slider	Slider	Add a new filter and save the properties.

ProfileListMenuObject
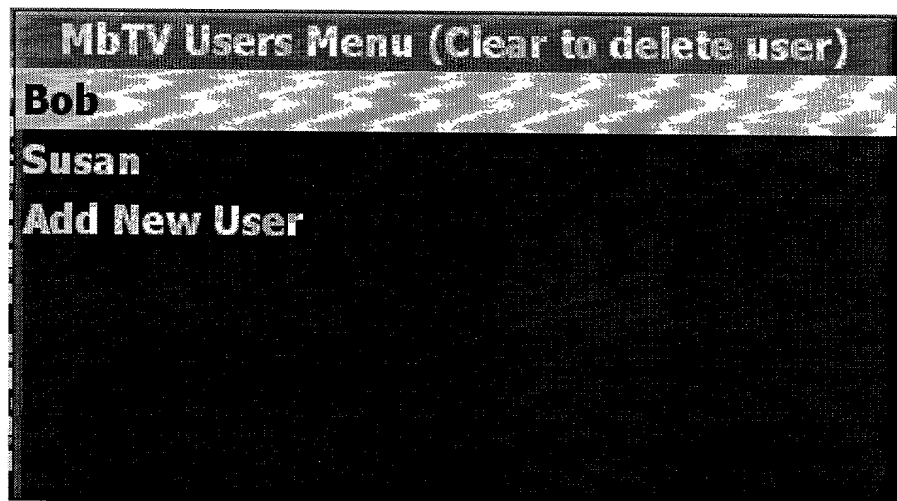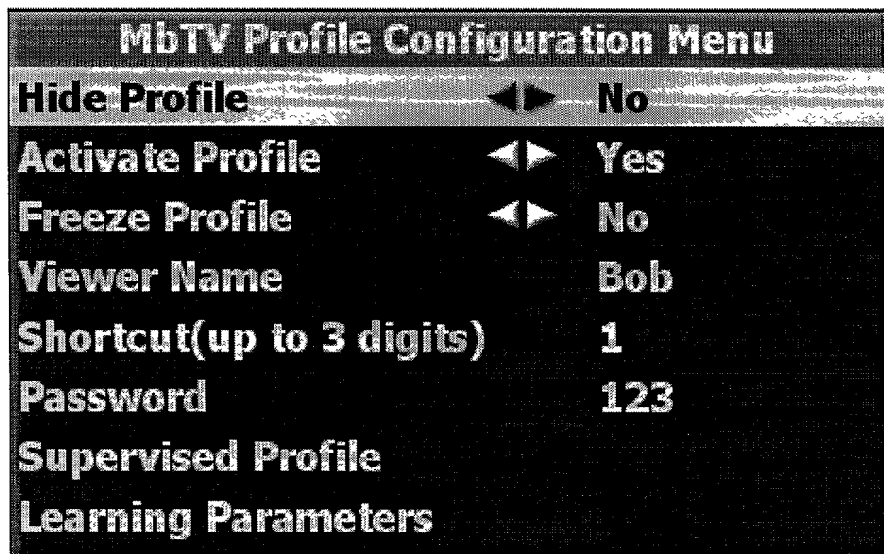
Before presenting this menu, query the list of profiles from PIM
using PIM*Profile functions. Please see PIM interface document
for details.
After adding these profile names to the menu, add another item
called Add New User to add a new user.

Menu Item	Item Values	Type of Item	Action On Enter
Profile Name(s)	None	Submenu	Profile Configuration Submenu
Add New User	None	Submenu	Profile Configuration Submenu

ProfilePropertiesMenuObject   (Properties of a profile)

Before presenting this menu, query the list of profiles from PIM using PIM*Profile functions. Please see PIM interface document for details.
After adding these profile names to the menu, add another item called Add New User to add a new user.
Remove Supervised Profile and Learning Parameters from this menu.

Menu Item	Item Values	Type of Item	Action On Enter
Hide Profile	Yes, No	List of values	Save the profile configuration
Activate Profile	Yes, No	List of values	Save the profile configuration
Freeze Profile	Yes, No	List of values	Save the profile configuration
Profile Name	Editable Name	Editable Field	Save the profile configuration
Shortcut	Editable Number	Editable Field	Save the profile configuration
Password	Editable Number	Editable Field	Save the profile configuration

AdminPasswordMenuObject   (Administrator Password)

Set a password to access administrator functions.

Following New menus are also defined for 0.3

➢ *New Menus*

MainConfigMenuObject   (Main Configuration menu)

Following three new options need to be added to main
configuration menu.
1. Recording Quality
2. Deactivate Learning
3. Premium Channels

RECORDING QUALITY

When Recording Quality is selected, the following menu will be
presented.

       RecordingQualityMenuObject   (Recording Quality Menu)

Channel
Program Type
Program Category
Country
MPAA Rating

      For each one of the above, defined list of filters is
presented as below.
      RQListMenuObject   (Defined List of Recording
Quality Filters)
      This is an example for "Program Type"

Sports
Movies
Add New Filter

      When Movies item in the above list is selected, as an
example, the following

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menu is presented.

RQShowMenuObject   (Properties of a Recording
Quality filter)

Program Type	Movies	
Recording Quality	**High**	(Normal/SuperHigh)
Delete Filter		

Current Recording quality for this type of program is
High and it can be changed
to one of the other options, if needed. Pressing enter
saves the new setting.

RQAddMenuObject   (Addition of Recording Quality
Filter)
When Add New Filter is selected, the following menu is
presented.

Program Type	Movies/Sports/News/TalkShows (From Dictionary)
Recording Quality	Normal/High/SuperHigh

User selects a program type and a recording quality
setting and presses enter.

DEACTIVATE LEARNING

DeactivateLearningMenuObject   (Deactivate Learning
Menu)
DLListMenuObject   (Defined List of Deactivate
Learning Filters)
Deactivate Learning Filter name is a combination of
channel and the start and end times.

CNN 8am-5pm
NBC 5pm-7pm
CBS 5pm-7pm
TNT 8am-5pm
TBS 11pm-5am

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DLShowMenuObject   (Properties of a Deactivate
Learning filter)
        Once one of the above items is selected, present a menu
with the channel
        information and

Channel	CNN
Start Time	8AM (Half Hour increments)
End Time	5PM (Half Hour increments)
Delete Filter	

DLAddMenuObject   (Addition of Deactivate
Learning Filter)

Channel Dictionary)	CNN (Scrolling
Start Time	8AM (Half Hour increments)
End Time	5PM (Half Hour increments)

PREMIUM CHANNELS

PremiumChannelsMenuObject
        ListOfPremiumChannels   (Each with subscription
information Yes/No)
        Get a list of premium channels using the following
calls.
        1. *EPGGetNumChannels(int *cntChannel)*
        2. *EPGGetChannelID(int channelIndex, void* channelID)*
        3. *EPGGetChannelParams(void* channelID, int paramNum,
           char *channelParam)*
        ParamNum of interest for us is EPG_CHANNEL_TYPE
        *If the channel type is "Premium" then save it to a
        local list.*

        *Present these channels information to the user along
        with two options (Yes/No)*

        *Once these are setup, next time they enter this are do
        we need to present the channels which are subscribed???*

MISCELLANEOUS

RECORDING ALERTS

When TV is on, in a one-tuner system, Explicit Recording Requests can not be fulfilled. These events are received by the CAPP/UI, and the message is formatted and presented to the viewer. *Recording Alters On/Off should we add this option to Settings??*

RECORDING CONFLICT RESOLUTION

RecordingConflictResolutionMenuObject   (When a SDMSetRecRequest indicates there is a

conflict, get all conflicts and present the info to

the user.)

As explained in the record menu, the conflicting record requests are formatted and presented to the user.

RECORD END DATE SPECIFICATION

RecordDateEndSpecificationMenuObject
  Add a new menu item to the record Menu which behaves as follows.
  1. If a periodic record request is selected, then the default value of this item should be Always. User may select an explicit end date at which time the record request is no longer in effect. The date selection in the first implementation will be a scrolling list of all dates.

  2. If Once is selected the only value of this item should be Once. No other options are available.

Having now described the invention in accordance with the requirements of the patent statutes, those skilled in this art will understand how to make changes and modifications in the present invention to meet their specific requirements or conditions. Such changes and modifications may be made without departing from the scope and spirit of the invention as set forth in the following claims.